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THE ELECTRIC MESSAGE

THE research station of the British Post Office at Dollis Hill, London, was open house to 1500 technical visitors last month. The staff of 1300 scientists, engineers and others were kept busy explaining the work they are doing in the communication field. Nearly 100 items of research were on show, relating to the analysis and coding of speech signals, long-distance transmission—radio and waveguide, submarine cable systems, the electronic telephone exchange, improvements in commonplace parts of the telephone system, mechanization of mail handling, and components and materials.

Two aspects of the work at Dollis Hill are referred to in articles in this issue of the *Journal*. The Anglo-Swedish submarine telephone cable is described on p. 588, and the Institution conference on electronic telephone exchanges is previewed on p. 596.

The cover illustration this month is concerned with the Anglo-Swedish telephone cable. It depicts a repeater just about to be launched over the stern sheave of a cable ship

Secretary W. K. BRASHER, C.B.E., M.A., M.I.E.E. *Editor* W. G. ASKEW, M.C.
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JOURNAL

OF THE INSTITUTION OF ELECTRICAL ENGINEERS

SAVOY PLACE LONDON W.C.2 VOLUME 6 NUMBER 70 OCTOBER 1960

15 TO 18 AND THE MANPOWER SHORTAGE

As practising electrical engineers, members are much concerned with the provision of adequate numbers of well educated young men and women who will ultimately join their ranks as Chartered Electrical Engineers.

In the United Kingdom, a number of official and semi-official studies of the problems associated with the supply of adequate numbers of the right quality have been made from time to time. Recently, for example, the Crowther Committee have presented Volumes I and II of their report entitled '15 to 18'. This voluminous effort deals, on a comprehensive basis, with the education in England of boys and girls between the ages of 15 and 18. It is well written, informative and would certainly justify study by parents and teachers, in particular.

The conclusions, contained in the first volume, are necessarily broad in character, but one or two which have a particular bearing on the training and supply of engineers are of special interest to members.

Attention is directed in the report to the growing difference between numbers of students 'qualified' to enter university courses and those 'selected' to do so. There can be little doubt that this gap accounts, in part, for the growing success in Britain of the diploma in technology courses operated by the National Council for Technological Awards.

The report goes on to criticize the means employed by the universities as a basis for selection. While we would not wish to enter into this particular controversy, there can be no doubt at all that it is imperative, in the national interest, to provide all young men and women who have some scientific and technical leanings with every opportunity to develop their capabilities to the full. Indeed, this problem has become so acute that it is necessary to consider possible means of attracting young people who have not specialized at school in all the subjects which have, so far, been regarded as imperative for an engineering career. It is more important to select for training, young men and women of the right temperament and calibre than it is to insist on precise conformation to normally accepted entry requirements.

The view is also advanced that very narrow specialization in sixth forms is undesirable; and it is pointed out that the open-scholarship system may lead to such narrowness, with detrimental effects on the individual student's breadth of knowledge and understanding. This is obviously a matter of degree, but it must be remembered that criticism is sometimes voiced concerning the alleged narrow outlook of professional engineers.

It is perhaps of particular interest to note how cogent arguments are evolved for the development of 'sandwich courses' for the 16–18 age group. It is contended, after a very painstaking analysis of wastage in part-time technical courses, that much greater percentages of passes are obtained by 'block release' courses than by 'day release' courses, and that better education is conferred. Where tentative experiments approaching full sandwich-course arrangements have been tried, results are demonstrably better still. So far, the rapid increase in sandwich-course students has been almost entirely for age groups of 18 and over, but the Crowther Committee consider that this facility should be extended to technician students of 16–18 years of age.

The Crowther Report, recognizing the national need for more technicians and technologists of the best possible quality, deals with the educational problems which must be faced if more young people are to be attracted to seek technical livelihoods and if, once started, they are not to be lost by the way, appearing eventually only in the 'wastage' column of some statistical survey.

In the same context, the 'Second report on scientific and engineering manpower in Great Britain 1959' is of interest, as it compares the manpower situation with that of 1956, when the first survey was published, and also attempts to forecast the position by 1962. The scope of this report is restricted to scientists and engineers,

defined as those holding certain qualifications such as university degrees, diplomas in technology and certain equivalent associateships, or corporate or graduate membership of certain learned societies, including, of course, The Institution.

Forward estimating is always a difficult exercise, and no less so in manpower. In the 1956 survey, estimates of demand by 1959 were assessed by correlating individual employers' statements. This resulted in a percentage increase of 28·7% in the demand for electrical engineers being forecast for 1959. In the event, the actual increase was 12·4%. It is, however, largely a matter of opinion whether the difference between these figures is due to overestimating in 1956 or to a real deficiency in 1959.

That there was some deficiency in 1959 cannot, however, be denied, and anyone with recent experience of the difficulty that exists in obtaining electrical engineering staff in Britain will probably take the view that the 1956 estimates of demand were not very far out, although the conclusion reached in the survey is that forecast requirements in the electrical engineering industry itself seem to have been overstated. If one does assume that there was an appreciable deficiency in 1959, the suggested further increase required by 1962 of 27·9% over the 1959 actual figure does not seem to be unreasonable.

The primary purpose of any survey of this kind must, of course, be to reveal in advance any potential gaps between supply and demand, so that any steps which are possible may be taken. Unfortunately, it necessarily takes a long time before a youngster at school can become a qualified electrical engineer, and, therefore, any measures to increase the supply take effect in a considerably longer period than three years. In the long run, however, surveys of this kind will prove to be of great value, provided that they are repeated at, say, three-yearly intervals.

That part of the report which deals with supply is inevitably more general in treatment, and the conclusions which are reached are comparatively broad.

For example, it is estimated that the net increase in scientists and engineers in Great Britain, during the three-year interval reviewed, was some 28000. On the assumption that wastage from all causes, including deaths and retirements, averaged 2½% per annum, the total number entering employment was 40000. This compares reasonably well with the number estimated as available for employment. Unfortunately, however, it has not been possible to break down these figures for electrical engineers, partly because of the general and pass degrees which cannot be classified and partly because a number of those admitted to professional institutions would hold more than one qualification.

In attempting to assess the over-all supply position, the committee responsible for the manpower report conclude that 47500 newly qualified people should become available for employment in Great Britain in the three-year period 1959–61, but that this number is still likely to fall short of employers' estimates of needs. Their report does, however, end on a note of optimism, as it points out that a higher output of trained men has been obtained than was forecast in 1956.

In electrical engineering there is still little cause for complacency. If industry is to hold its own in world markets, no effort must be spared to encourage recruitment and to improve and extend facilities for education and training. In the long run, success will turn on the attractions the profession has to offer.

Changes in fusion research programme

With the announcement last month that the Intermediate Current Stability Experiment (I.C.S.E.) had been abandoned, the United Kingdom Atomic Energy Authority revealed a major change in their programme of research towards the commercial use of fusion as a source of power. Instead of concentrating available effort on a single experiment, which was found to cost nearly £2 million more than originally anticipated, the Authority have decided to proceed with several smaller pieces of apparatus until more is known of the technology and theory of achieving the necessary stability.

It was thought, nearly two years ago, that the construction of this large-scale experiment in plasma physics would cost about £1½ million, but more recent estimates have put the figure at over £3 million.

I.C.S.E., though generically like Zeta, was expected to show greater stability, since the current was designed to rise about 60 times as fast as that in Zeta, resulting as a skin current rather than a distributed current. Theory also suggested that hydromagnetic stability could be achieved by applying an additional stabilizing magnetic field outside the plasma. The objects of the experiment were the investigation of the stability of this improved pinch configuration and the checking of present stability theory. The apparatus was, however, designed to enable many parameters affecting stability to be varied over a wide range.

In its place, a number of smaller experiments (four or five, costing £50000–£100000 each) will be set up, thus broadening the research programme. The production of fusion energy for commercial use will continue to be the aim, and perhaps in a few years' time the smaller experiments will yield sufficient information to justify the construction of larger apparatus. There is an embarrassing choice of configurations to be studied, but it is known that the small experiments are likely to include work on the thetatron and hard-core geometry.

The new Culham laboratories of the Authority will continue as the basic research laboratories for fusion.

The Second Hunter Memorial Lecture

621.316.9 PROTECTION OF A.C. SYSTEMS

At an Ordinary Meeting on the 7th January 1960 at Savoy Place, Mr. Bell delivered the Second Hunter Memorial Lecture, taking as his subject the protection of electrical systems (see March 1960 Journal, p. 189). He provided a survey, intended for electrical engineers practising in other fields, of the functions and applications of protective gear, indicating the types of relay used, the various methods of applying them to achieve discriminative fault clearance, and the present state of development.

This article represents a much condensed version of the Lecture—which has also been delivered in a number of the local Centres of The Institution. Mr. Bell is a Consulting Engineer to Associated Electrical Industries (Manchester) Ltd.

H. G. BELL, M.SC.TECH., MEMBER

PROTECTIVE gear is an essential component of any transmission or distribution system. Its function is to detect abnormal conditions in the system and to initiate the disconnection of faulty elements, so that interference with the general supply is minimized.

Abnormal conditions in supply systems can arise from many causes. Lightning, storm, salt deposits, etc. may cause flashovers on overhead lines; subsidence and building operations may damage underground cables; insulation in all kinds of apparatus may fail; and the human element, whether in driving a crane into a overhead line or a car into a distribution pillar, can cause damage to sections of the system.

Taking for example the network of electricity supply in England and Wales, which comprises 250000 miles of overhead and underground circuits with 180000 substations, incidents requiring the operation of protective gear occur at the rate of 6000 per annum, or about 20 per day.

By rapid operation to ensure the isolation and making dead of faulty elements, the amount of damage and consequent cost of repair are limited. At the same time, the remainder of the system can continue to function normally. The knowledge that a fault in one feeder will not cause widespread disturbance and unwanted tripping of healthy circuits enables the system to be planned economically, without undue duplication of equipment.

When a fault takes place in a system, the impedance of the load is shunted by the much lower impedance of the fault, so that very heavy fault currents are superimposed on the much smaller load currents. These fault currents may on occasions amount to 40 times the normal load of a circuit. From the point of view both of damage and of stability of plant, quick clearance is essential.

The heavy fault currents flow in lines and apparatus feeding into the faulty unit as well as in the faulty unit itself, and it is just as important that healthy elements carrying such through fault-currents should not be tripped as that the fault itself should be isolated. This requirement is known as discrimination.

In this country, the supply regulations require that every circuit shall be protected against excess energy and that systems shall be so arranged as to localize the effect of any disturbance.

Protection and system design

The design of protection for a system and the design of the system itself are closely interdependent. By suitable lay-out of stations and feeders, the protective problems can be simplified, while the knowledge that system faults will be quickly and discriminately cleared gives the designer more freedom by improving the stability of the system and reducing the requirements for spare plant.

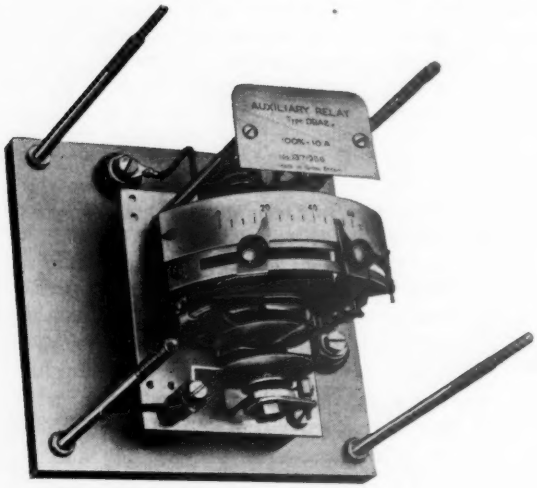
An important aspect of system design affecting the protection is the method of earthing the neutral point. Up to about 1912, the majority of h.v. systems in the United Kingdom operated with insulated neutrals, but as h.v. feeders increased in number and length this arrangement was no longer practicable. All systems in this country are now earthed at one or more points, either directly or through a limiting resistor; in the latter case, suitable sensitive earth-fault protection may be required.

H. G. Bell

Current transformers

On high-voltage systems, protective relays are connected to the primary conductors by voltage and current transformers. The requirements of current transformers for protective purposes differ from those of transformers for metering. For metering purposes, accuracy is essential at normal loads and up to small overloads, but is of little importance at higher values, whereas for protective current transformers high accuracy up to normal load is of little importance, but reasonable accuracy over a range extending to 20 or 30 times normal load may be required.

Another parameter in the design of protective current transformers is the secondary current. In applications where instruments or relays are near the current transformers feeding them, 5amp is a satisfactory secondary current. In many protective applications, however, the current transformers and relays are separated by considerable distances, and the connecting leads may impose a considerable burden on the current transformers. For instance, in a 5amp circuit, 1 ohm in the leads represents a burden of 25VA, but by adopting a secondary current of 1amp this can be reduced to 1VA—which may simplify the design of the current transformers.



1 *Modern form of moving-coil relay*

Protective relays

Protective relays are of many types. Some depend on the attraction of an armature by some form of electromagnet. These are usually quick-acting, though slight delays can be introduced by various means. A very large number of relays operate on the induction principle; these are specially suitable as directional relays and overcurrent relays with time delays, and they are particularly robust and reliable.

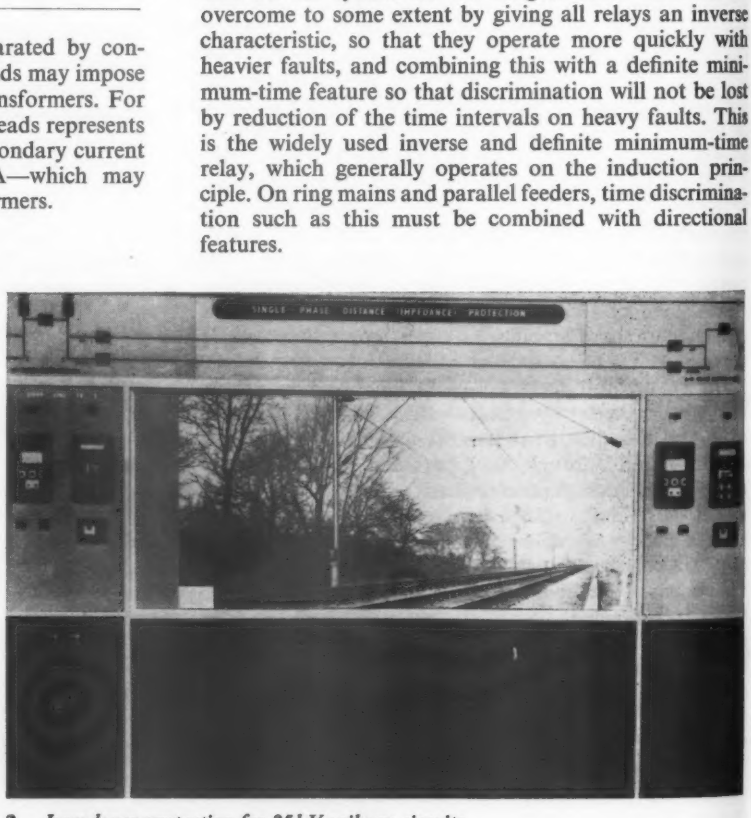
A third type of protective relay utilizes the principle of the moving-coil instrument, where a fine-wire coil, generally wound on a light former, moves in the air-gap of a powerful permanent magnet. In some relays the movement is rotary, the coil being supported by pivots (see Fig. 1), while in others the coil may move axially, being suspended by leaf springs. As such relays require direct current for operation, application to a.c. protective systems involves the addition of rectifiers. Some relays operate on thermal principles; others, such as the Buchholz relay for transformer protection, on hydraulic principles.

All primary protective relays are provided with devices to indicate when the relay has operated. The evidence given by these operation indicators often assists in the investigation of complex faults.

Time discrimination

Discriminative protection in a system can be obtained either by some form of time discrimination or by so-called 'unit' protection. The simplest form of time discrimination is obtained on a series of radial feeders by arranging current-operated relays to have progressively shorter time delays as the distance from the power source increases, the interval between successive relays being sufficient to allow for breaker operation. In such an arrangement, a fault in the most remote feeder causes all relays to start to operate, but the relay nearest the fault, having the shortest time of operation, initiates the clearance of the fault, after which all the other relays will reset.

This simple technique has the disadvantage that the heaviest faults—those nearest the feeding-point—are held on the system for the longest time. This can be overcome to some extent by giving all relays an inverse characteristic, so that they operate more quickly with heavier faults, and combining this with a definite minimum-time feature so that discrimination will not be lost by reduction of the time intervals on heavy faults. This is the widely used inverse and definite minimum-time relay, which generally operates on the induction principle. On ring mains and parallel feeders, time discrimination such as this must be combined with directional features.



2 *Impedance protection for 25kV railway circuits*

Distance protection

A method of overcoming the limitations of simple time discrimination for feeders, without having recourse to unit protection, is the use of distance protection. In this type of protective gear, the relays are supplied from current and voltage transformers associated with a feeder and, in fault conditions, deduce the distance of a fault from the apparent impedance, reactance or admittance of the feeder to the fault.

In some types of distance relay, the time of operation is made to depend on the distance of the fault, so that near faults are cleared more quickly, while in others instantaneous operation is given for faults up to about 85% of the feeder length, more remote faults being cleared after a definite time delay, progressively increasing in steps. Directional features can be combined with these relays when necessary. A typical equipment of this kind is illustrated in Fig. 2.

Both time-discrimination and distance relays provide back-up or second-line protection, since, if any relay should fail to clear a fault in its correct time, the relay with the next longer time would operate to clear the fault, though with more disturbance to supplies.

Unit protection

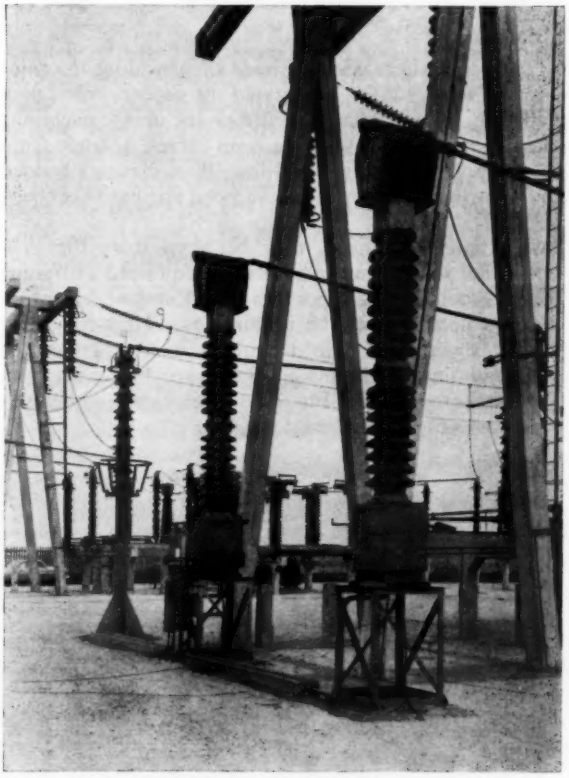
In complex systems, and where rapid clearance is required for all faults, unit types of protection are widely used. This originated with the circulating-current and balanced-voltage patents of Merz and Price in 1904. The basic principle is to compare the current entering and leaving each phase of the protected unit, and to use any out-of-balance current to initiate tripping.

Circulating-current protection is used where the sets of current transformers are close together, as is generally the case in machine and transformer protection. The current transformers are connected so that current circulates between their windings in normal conditions. Relays are connected between normally equipotential points on the small wiring, so that they are energized by any spill or out-of-balance currents due to an internal fault.

Circulating-current protection is chiefly used for machine and transformer protection, but for transformers allowance must be made for the change of phase and current magnitude between the two sides, for the disturbance of normal balance as a result of operation of tap-changing gear, and for magnetic in-rush currents on switching. It is also used for the protection of important sets of busbars which are not covered by the back-up protection of the main feeders. For busbar protection, it is usual to include a check feature and sometimes a form of supervision.

Balanced-voltage protection is used for feeders, since the resistance of the comparatively long pilot connections would impose too heavy a burden on the current transformers of a circulating-current system. In opposed-voltage conditions, however, normal current transformers would saturate, so to preserve proportionality air-gaps are introduced into the iron circuits. The current transformers at the two ends of the feeder are connected through sensitive relays and pilot cores, but, since the secondary voltages are opposed, no current flows in the pilot wires except in fault conditions.

As fault currents became heavier and pilot wires longer, however, capacitance currents in the pilots sometimes caused unwanted tripping. This difficulty



3 *Line trap for 275 kV carrier protection*

was overcome by the Beard–Hunter arrangement, in which sheaths surrounding the pilot cores shunt the capacitance currents from the relays.

Many modern unit systems designed on these two basic concepts are in use today, but include improvements to suit the more exacting conditions in modern networks, such as bias features actuated by fundamental-frequency or harmonic currents.

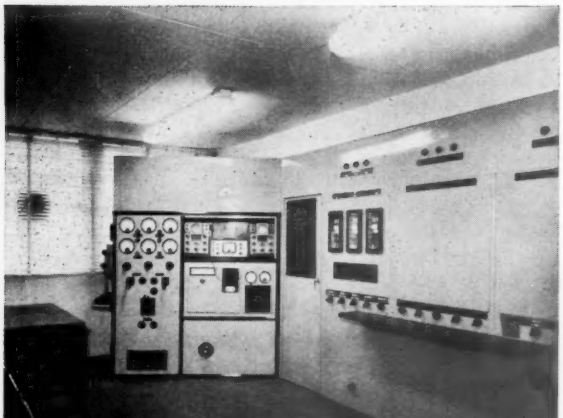
These types of unit protection rely on a quantitative comparison of the currents at the two ends of the protected element. There is another class, which compares qualities such as direction of power flow, phase of current, etc., so that only a qualitative signal need be sent over the pilot circuits and accurate balancing of components is unnecessary. So-called lock-in and high-frequency carrier schemes are of this type.

Where unit forms of protection are employed, since each is inherently stable except for faults within its own protected area, separate back-up protection must be furnished to provide for the contingency of failure to clear the fault by the primary protection. This back-up protection may take the form of overcurrent or distance protection, and is arranged to operate, in a rather longer time, should the faults persist beyond the time of operation of the first-line protection.

Pilot circuits

There are alternative methods of providing the pilot circuits required for unit types of feeder protection. Separate pilot cables, sometimes including telephone circuits, may be laid with the main cables, or slung from the supports of an overhead line. Pilot cores embedded in the earth conductor of an overhead line have also been used.

Alternatively, circuits may be hired from the Post Office, but such circuits are normally equipped with some form of continuous supervision, and special insulation may be necessary at the terminations. High-frequency carrier signals fed into the main conductors of an overhead line by means of line traps and capacitors such as those shown in Fig. 3 are often used, and beamed radio links are sometimes possible.



4 *Control of 5 MVA relay test plant*

When pilot cables laid near the main circuits are used, and primary currents of considerable magnitude can flow during earth faults, longitudinal voltages of the order of 4–5000 volts can be induced along the cores of the pilot cables from end to end. This demands a high standard of insulation in the termination equipment.

Where pilot cables are used for intertripping purposes, d.c.-operated relays can be employed, but they must be rendered immune to alternating currents to avoid the chance of operation by induced currents. Intertripping of a transformer feeder can be carried out in the absence of pilot wires by applying an artificial fault to the feeder after the local breakers have operated.

Alternative means of protection

There are many other types of protective relays and systems, such as neutral-displacement, negative-phase-sequence, temperature, Buchholz, frame-leakage, etc., which find useful application in special circumstances. Transient faults can be cleared without interruption to supplies by such means as arc-suppression coils, shunt circuit-breakers or high-speed single- or multiphase reclosers.

Fuses are still available for all voltages, but the majority are employed on medium-voltage networks. The modern h.r.c. fuse is accurate and dependable and possesses the great advantage that, on heavy faults, owing to its extremely high speed of operation, it limits the fault current to a fraction of the prospective value, with consequent reduction in the magnetic forces and thermal damage.

On modern systems, rapid clearance of faults is important, to maintain stability and to limit damage. Over the years, the time of operation of unit systems has been gradually reduced until, today, protective gear can be supplied to operate in two cycles, which, with switch operation of three cycles, gives clearance in about 0·1 sec.

To obtain reliable operation of protective gear at such high speeds, it is necessary to provide compensation for the transient effects which arise in fault conditions in the primary and secondary circuits. Since these decay during the first few cycles, they may be ignored in the design of equipment operating more slowly.

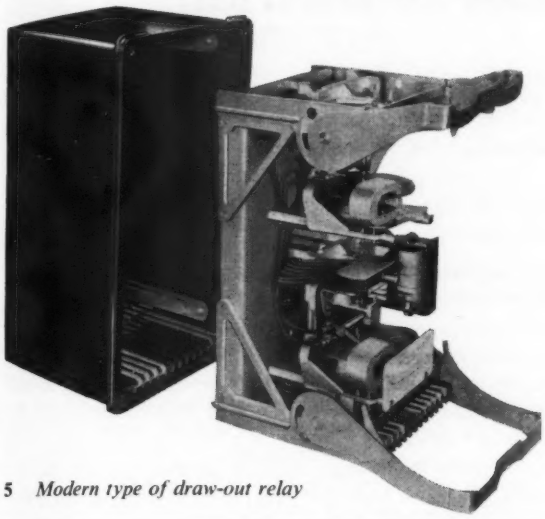
Unit types of gear were originally satisfactory if stable during through faults of 10–15 times full load. The increased concentrations of fault power have rendered such stability insufficient, and up to 30 or more times full load is frequently necessary.

Development work

Knowledge of protective-gear performance in all conditions is constantly being extended from various sources. Recorders with a memory feature are installed at suitable points in the networks to record the development and variations of complex faults. Tests on large and small scales are carried out from time to time on systems to clear up specific points. Development work on laboratory scale, designed to simulate system conditions, is constantly being carried out in manufacturers' works (see Fig. 4). In addition to this, old and new systems are set up on analogue computers, to investigate system behaviour in healthy and faulty conditions.

No comprehensive record of the performance of protective gear in service existed in this country before the advent of the national Grid, but since then the percentage of all incidents in which all protective gear

concerned has operated correctly has been published annually. This figure is now about 90%, which represents a very high standard of design, manufacture, installation and maintenance, as there are a number of conditions for which full cover cannot be justified on economic grounds.



5 *Modern type of draw-out relay*

The development of protective gear was originally largely by rule of thumb, but in recent years the main variable and transient factors involved have yielded to mathematical treatment, so that performance can be assessed on a firm basis. Rectifiers and materials with non-linear voltage/current characteristics which have proved their reliability in service are accepted components of many modern schemes of protection. Developments based on transistor and allied techniques will probably be a major feature in the next decade, provided that transistors and similar devices can be shown to possess the permanence of characteristics which is essential for protective-gear applications.

In the design of relays, steady improvements follow the development of new and improved materials. Printed circuits have found application in some types of relay. As a result of the fashion for flush-mounted relays, designs have been developed in which the relay can be withdrawn from the case for inspection without breaking the current-transformer circuits (Fig. 5).

The high cost of primary equipment tends to force system designers to reduce the amount of switchgear employed. This is often possible only at the expense of additional complications in the necessary protective gear.

Summary

The operation of any modern supply system would be impossible without satisfactory protective gear, which in the present state of the art can provide, when necessary, for fault clearance in 0·1 sec. A wide variety of relays and methods of application are available to suit the diverse demands arising in practice. Important developments based on transistor and allied techniques are probable in the near future.

Reorganization of inspectorates

On its abolition in October 1959, the Ministry of Supply's procurement responsibilities were divided between the War Office and the Ministry of Aviation. As responsibility for development, production and contract action for certain classes of equipment has been transferred to the War Office, it has been decided that inspection responsibility shall be similarly transferred.

From the 1st November 1960, the Inspectorate of Armaments (I.Arm.), the Inspectorate of Fighting Vehicles and Mechanical Equipment (I.F.V.M.E.), and the Chemical Inspectorate (C.I.) will, with certain minor exceptions, be transferred to the War Office and will be responsible in due course to an Assistant Master-General of Ordnance (Inspection). The Aeronautical Inspection Directorate (A.I.D.) and the Electrical Inspection Directorate (E.I.D.) will remain with the Ministry of Aviation and will be responsible to a Director-General of Inspection.

Arrangements have been made to preserve the benefits which have resulted from unification of control in the Ministry of Supply, while giving the inspection responsibility for a particular store to the Department responsible for its procurement. The War Office will accept Ministry of Aviation inspection in the aircraft, guided weapons, electrical and electronic fields, and the Ministry of Aviation will accept War Office inspection in the vehicle, armament and chemical fields.

Apart from some relatively minor adjustments, the inspectorates will continue to deal with the same classes of equipment as before. The inspection of all aircraft and guided weapons will remain with A.I.D.; that of all electrical and electronic equipment, with very minor exceptions, will remain with E.I.D.; and that of non-metallic materials will remain the responsibility of C.I. Each Department will be responsible for the inspection of its own metallic materials, but A.I.D., in consultation with the War Office inspectorates, will set and maintain the standards of physical testing.

Regional Superintendents of Inspection, who will in future serve both Departments, will co-ordinate the inspectorates, which will continue to collaborate closely. The present regional and district boundaries will be unchanged, and the headquarters offices of the different inspectorates in regions and in districts will continue in the same buildings.

Digital computers as design aids for electrical engineers

621.3:681.142

It has now become practical for engineers to use electronic digital computers in their day-to-day work—by using machines at centres on a part-time basis, and by exploiting simplified techniques for preparing the work. An example is given of the complete process of preparing a calculation, using a simplified scheme.

The paper is based on a lecture delivered at a District Meeting of The Institution at Oxford on the 7th October 1959. Mr. Ross is with Ferranti Ltd.

H. McG. ROSS, M.A., ASSOCIATE MEMBER

During the last five years or so, intensive efforts have been made to simplify the use of electronic digital computers, and to establish techniques for employing them on a part-time basis. These are now coming to fruition. Many engineers have learnt how to use the machines, and are able to prepare their own work and to run it on computers at centres. Thus these powerful tools are made available for many of the everyday jobs in engineering work, in addition to complex and lengthy calculations. Much of this simpler work can be completed on a computer in minutes rather than hours, and it is common to find that 30 or 40 problems are run on one computer in each working day.

Using a computer

Fig. 1 shows how one of these machines is used. Perhaps the hardest task is the complete and precise analysis of the problem.

Throughout the process of preparing the programme of instructions, we have to do all the thinking for the computer, not only the main line of attack but also every exceptional condition which might possibly arise, and we must provide ways for these to be coped with. The link between human beings and the computer is most commonly by means of punched paper tape or punched cards. The programme and the data for the job on hand are punched (Fig. 2) and carefully verified.

The computer must 'read in' the programme and store it within its memory; only then is it capable of doing useful work. By moving a switch, the computer is made to begin to obey the programme, reading in data, computing, and ultimately printing out results.

Fig. 1 shows that writing a programme can take a long time, but this does not matter if it is for a job that may have to be done again and again, since the same programme can be used repeatedly for the same type of problem but with different data on each occasion.

Importance of the programme

The point to be emphasized with digital computers is that it is the programme which matters, for the following reasons:

1. Almost all the human effort which is needed in solving a problem goes into the preparation of the programme
2. A computer is very rapidly changed over from one job to another, merely by reading in a new programme; it is this which makes it practical for many people to use one computer, either within one organization or by visiting a computer centre
3. Virtually no changes have to be made to the equipment to make it tackle one kind of job rather than another (although special attachments, usually input and output machines, may sometimes be needed for certain types of work, especially in the clerical data-processing field).

Programme library

Most programmes are long and involved because they have to be made up from a large number of very elementary instructions. This tends to make it difficult for the ordinary engineer to use computers. There is thus an incentive to simplify programming.

The first way in which we can do this is to exploit the work of others. With every established computer there is available a library of programmes and subroutines, these latter being a type of building brick for programmes. Wherever possible, one's programme incorporates these items from the library; they are highly perfected so that they may work properly in the most varied circumstances, with full instructions provided.

Simplified programming techniques

The second major way in which programming is being assisted is by the use of simplified programming schemes. Strictly, these effect a translation between a user's notation and the true machine instructions; they may, however, be thought of as transforming the computer into a much simpler machine. It becomes simpler to understand, and its instructions are easier to write, being more nearly related to normal mathematical notation.

Repeated experiments have shown that such schemes are easy to learn: men with no previous experience of computers have been given the handbook and a simple problem, and have learned the scheme, written the programme and produced results from the computer within their first day.

Of course, such an advantage cannot be got for nothing; these schemes take away some of the flexibility and versatility of a computer, and reduce its speed. The larger and more powerful the computer, the less it is affected.

A transformed computer

I shall now describe such a simplified computer, and show how to tackle a typical small engineering calculation, in which there are columns of numbers on the page which have to be worked together to produce further columns of results.

The memory of the computer, shown in Fig. 3, holds our simplified programme and a large number of numbers. We wish to be able to refer to these numbers, and yet, while writing the programme, we do not know their values; accordingly, we use a symbolic notation $v0$, $v1$, $v2$, . . . for most of the numbers, called variables, and $n0$, $n1$, $n2$, . . . for some other numbers, called indices. The input devices will put programme or data into the memory, and the output punch and typewriter will print the results. There are two control switches.

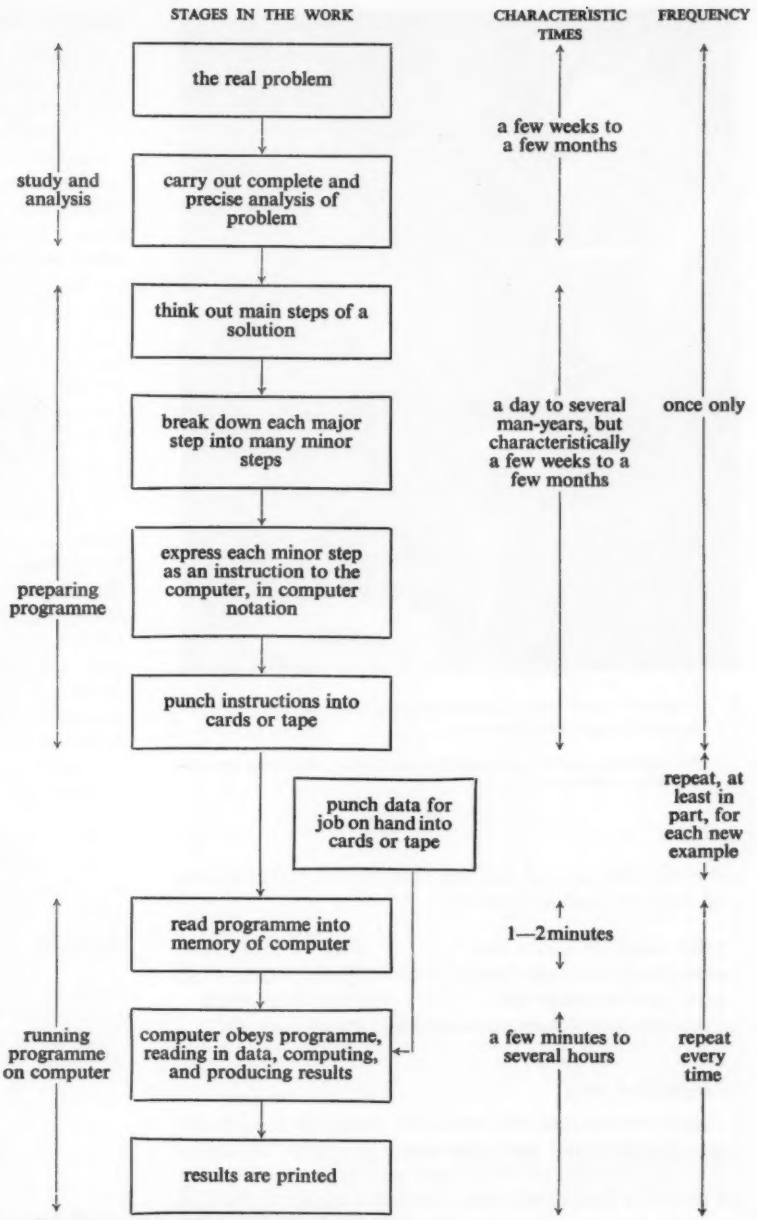
Writing a simple programme

Our example (admittedly trivial) will be the computation of the areas and moments of inertia ($\frac{1}{12}wh^3$) of a series of beams of rectangular section, having been given the widths w and heights h of their cross-sections. The data would be punched on paper tape, first the column of widths and then the column of heights.

One of the early instructions in the programme will be to make the computer read in the data. Suppose that we wish to put the column of widths in the memory as $v100$, $v101$, . . . proceeding successively, then we should write the instruction: $v100 = \text{TAPE}*$. The effect of this instruction is that the value of $v100$, *after the instruction has been obeyed*, is to be made equal to the number on the tape; and successively for all other numbers in that column (until a terminating mark).

An instruction to read in the column of heights would be: $v200 = \text{TAPE}*$.

Now we want to work out the area, for which we can use $v1$, so we write $v1 = v100 \times v200$. This means that the value of $v1$, after the instruction has been completed, is to be the first width multiplied by the first height.


STAGES IN THE WORK
CHARACTERISTIC TIMES
FREQUENCY
the real problem
a few weeks to a few months
study and analysis
carry out complete and precise analysis of problem
think out main steps of a solution
break down each major step into many minor steps
a day to several man-years, but characteristically a few weeks to a few months
once only
express each minor step as an instruction to the computer, in computer notation
preparing programme
punch instructions into cards or tape
repeat, at least in part, for each new example
punch data for job on hand into cards or tape
read programme into memory of computer
1—2 minutes
computer obeys programme, reading in data, computing, and producing results
running programme on computer
a few minutes to several hours
repeat every time
results are printed

1 *The stages of tackling a practical problem*
The programme of instructions is the most important feature of digital computers

To work out the moment of inertia:

use $v2$ for wh^2, and write $v2 = v1 \times v200$
use $v3$ for wh^3, and write $v3 = v2 \times v200$
use $v4$ for $\frac{1}{12}wh^3$, and write $v4 = v3 / 12$

Now we can write the instructions to print the first line of results as follows (where the final code numbers

2 *Punched paper tape or punched cards are the link between human beings and computers*

An engineer punches his data for a calculation, obtaining simultaneously a typed record

determine the lay-out and the numbers of places before and after the decimal points):

print width on a new line	PRINT *v*100, 3042
print height on same line	PRINT *v*200, 4082
print area on same line	PRINT *v*1, 4122
print moment of inertia on same line	PRINT *v*4, 4162

A repetitive loop

These instructions will make the computer read in the data and work out and print the first line of the table. To avoid the need to write down similar instructions for all the other lines in the table, we next write an instruction to make the computer jump back to an earlier point in the programme. We write →1, and put a label 1) before the instruction to which the jump has to go.

After the computer has worked through these instructions for the first time, it will enter the loop we have formed and establish a repetitive process. This technique of using a repetitive arithmetic process, and establishing loops of instructions by means of jumps, is one of the most fundamental in the use of computers. Loops, written only once by the human being, may be obeyed thousands or even millions of times by the computer during the course of a calculation.

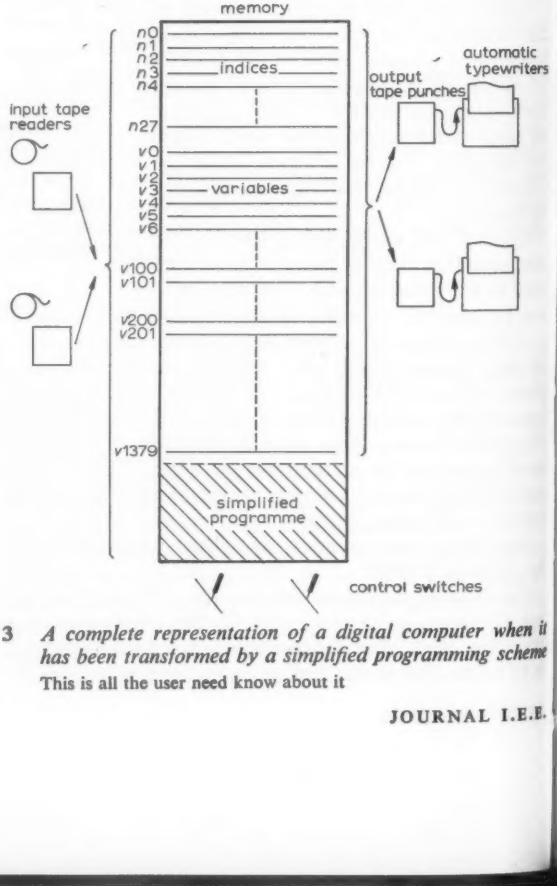
Modification of instructions

The loop we have established is defective in that it will always work out and print only the first line of our table. We overcome this by the following artifice. We use one of the indices to help to select the data which have been stored in the memory. We set $n1 = 0$ initially, and then we introduce, before the jump instruction, an instruction which will increase the value of this index by unity, thus: $n1 = n1 + 1$. We also have to rewrite some of the other instructions, so that our programme looks like:

```
      v100 = TAPE•
      v200 = TAPE•
      n1 = 0
1)    v1 = v(100 + n1) x v(200 + n1)
      v2 = v1 x v(200 + n1)
      v3 = v2 x v(200 + n1)
      v4 = v3 / 12
      PRINT v(100 + n1), 3042
      PRINT v(200 + n1), 4082
      PRINT v1, 4122
      PRINT v4, 4162
      n1 = n1 + 1
      →1, n0 > n1
```

On following through this the first time, it will be found to be exactly the same as before until the jump has taken place. Thereupon the computer will interpret the instruction $v1 = v(100 + n1) \times v(200 + n1)$ in the following way: it will observe the current value of $n1$ (which is 1) and add this to 100 (and to 200) to make this instruction appear as $v1 = v101 \times v201$. The computer will therefore work out and print the area and moment of inertia of the second pair of data. Every time round the loop, the value of the index $n1$ will be increased by unity, thus working right through our table.

With this technique, which is called modification of



3 *A complete representation of a digital computer when it has been transformed by a simplified programming scheme*

This is all the user need know about it

instructions, we have made the computer progress itself systematically through the data. It is of exceptional value in all cases where there is any systematic arrangement in the data or where calculations are to be repeated in any systematic way, for example with uniform increases of some parameter.

Taking a decision

So far, we have not told the computer how to stop this repetitive process. To do this, we must arrange the programme to exploit one of the most powerful facilities of a digital computer—its ability to be instructed to take certain elementary decisions.

We do it in this way. When the data were being read in, index $n0$ was automatically set equal to the number of items of data. If we now rewrite the jump instruction to mean 'jump to 1 if $n0$ is greater than $n1$', and follow it by the instruction 'stop', this will make the computer 'take a decision'. Every time the instruction is reached, a test will be made to determine whether $n0$ is greater than $n1$. To begin with, of course, this will be the case, and the jump will take place; but when the last row of our table has been printed the test will not hold, the jump will not take place, and instead the computer will proceed serially to the next instruction, and stop.

The complete programme is seen in Fig. 4; it is punched into the programme tape in exactly this form, and accepted by the computer. A print-out of typical results is also shown.

Summary

Programmes lie at the heart of digital computers; they account for the versatility, the power, and the facility for many people to use one machine. Programming can be assisted by exploiting the work of others or by using the new simplified schemes. An example has served to describe the essential features of a computer and to show how a programme is prepared; it illustrates the three basic concepts—repetitive loops, modification of instructions, and taking decisions. This will perhaps suggest ways in which engineers may find it worth while to use computers in their work.

PROGRAMME

```
D
N

TABLE OF AREAS AND MOMENTS OF INERTIA OF RECTANGULAR BEAMS.

 WIDTH   HEIGHT      AREA      M. OF I.

    J1.0
    STOP
    v100 = TAPE.
    v200 = TAPE.
    n1 = 0
1)  v1 = v(100 + n1) x v(200 + n1)
    v2 = v1 x v(200 + n1)
    v3 = v2 x v(200 + n1)
    v4 = v3 / 12
    PRINT v(100 + n1), 3042
    PRINT v(200 + n1), 4082
    PRINT v1, 4122
    PRINT v4, 4162
    n1 = n1 + 1
    J1, n0 > n1
    STOP
    (>0)
    zzzzz
```

RESULTS

```
25/9/59--34

TABLE OF AREAS AND MOMENTS OF INERTIA OF RECTANGULAR BEAMS.

 WIDTH   HEIGHT      AREA      M. OF I.

+1.00    +1.00      +1.00       +0.08
+1.00    +1.50      +1.50       +0.28
+1.00    +2.00      +2.00       +0.67
+2.00    +1.50      +3.00       +0.56
+2.00    +2.25      +4.50       +1.90
+2.00    +3.00      +6.00       +4.50
+2.00    +3.75      +7.50       +8.79
+5.00    +3.50     +17.50      +17.86
+5.00    +5.00     +25.00      +52.08
+5.00    +6.50     +32.50     +114.43
+5.00    +8.00     +40.00     +213.33
+12.00   +6.00     +72.00     +216.00
+12.00   +9.00    +108.00     +729.00
+12.00   +12.00   +144.00    +1728.00
+12.00   +18.00   +216.00    +5832.00
+12.00   +24.00   +288.00   +13824.00
 +0.50   +0.50     +0.25       +0.01
 +0.50   +0.75     +0.37       +0.02
```

4 *Facsimile (top) of the print-out of the complete programme used as an example, and (bottom) of the results*

The date and serial number are inserted by the computer; the title and column headings are copied from the programme tape; the first two columns are copies of the data: and the last two columns are computed. Thus the sheet of results is automatically made complete and fully annotated

RESISTIVITY METER FOR DOUNREAY

Sodium or sodium–potassium cooling circuits of such reactors as the fast breeder reactor of the United Kingdom Atomic Energy Authority at Dounreay need a continuous check that the amount of oxygen in the coolant is being kept as low as possible, to avoid formation and deposition of oxide in the circuits.

An instrument, based on the fact that impurities in a metal increase its resistivity, and known as a resistivity meter or rhometer, has been developed at Dounreay to perform this task.

An increase of oxygen of 1 part in 10^6 by weight in liquid sodium–potassium raises its resistivity by about 100 parts in 10^6 at 300°C. A temperature change of 0·04°C will produce the same change in resistivity, and one of the major features of the rhometer is the way in which it compensates for temperature changes.

Measurements with the rhometer are made on liquid metal drawn from the main circuit and passed through a toroidal pipe forming the secondary load of a transformer with a double-loop magnetic core.

The meter can identify gas bubbles by the large resistivity changes they produce, and has been used to locate the origin of gas entrainment in the Dounreay reactor. Oxide particles passing through the meter can be seen as pulses on the recorder chart, so the meter can also indicate whether the oxygen content is above or below the saturation level and thus saturation temperature can be determined.

PLANNING AND INSTALLING A TELEVISION STATION

621.396.712:621.397

The basic factors in planning a television station are mentioned, including site, mast height, aerial gain, method of operation and transmitter power, staffing and building design. Brief reference is made to general financial considerations and to the installation programme. The article is based on a lecture delivered to the Southern Centre of The Institution on the 11th November 1959. Mr. Weigall is with the British Broadcasting Corporation.

D. B. WEIGALL, M.A., MEMBER

THE planning of a new television station usually starts with the requirement that it shall fit into an existing transmitting system, which may determine much of the design. For the present purposes, however, it is assumed that the station has to serve a specific area and that only the frequency band has already been determined.

In many parts of the world, all channels in Bands I and III and many in the higher bands are already in use, so that the initial problem is to determine those conditions which will permit the radiation of the power required in each direction without causing an unacceptable level of co-channel interference with existing services at home and abroad. With this in view, it is necessary to choose site, channel, polarization, mean aerial height, and horizontal-radiation pattern.

From the horizontal-radiation pattern the mean effective radiated power (e.r.p.) can be deduced.

After a preliminary selection of the most suitable possibilities, the plans can be developed to cover:

aerial gain; mast height; transmitter power and method of operation; programme sources; staffing; site and building lay-out; cost estimate; and erection and installation programme.

Many of these factors are interdependent, so that a number of tentative plans may have to be worked out and costed for comparison purposes.

Site

Owing to the near-optical characteristics of electromagnetic waves at the frequencies used for television, the site selected is, in general, on high ground overlooking the target area. It may be located near the middle of the area with an omnidirectional aerial, or may have to be displaced off-centre with a directional aerial. This latter possibility may be necessitated by e.r.p. restrictions due to co-channel working or by ground contours.

For stations which reradiate signals picked up from another station by either a local or a remote receiving station, the location of the transmitting site may be considerably affected by the problems of reception. More and more stations receive their programmes in this way and rebroadcast them on a different channel, as this saves the revenue cost of programme circuits.

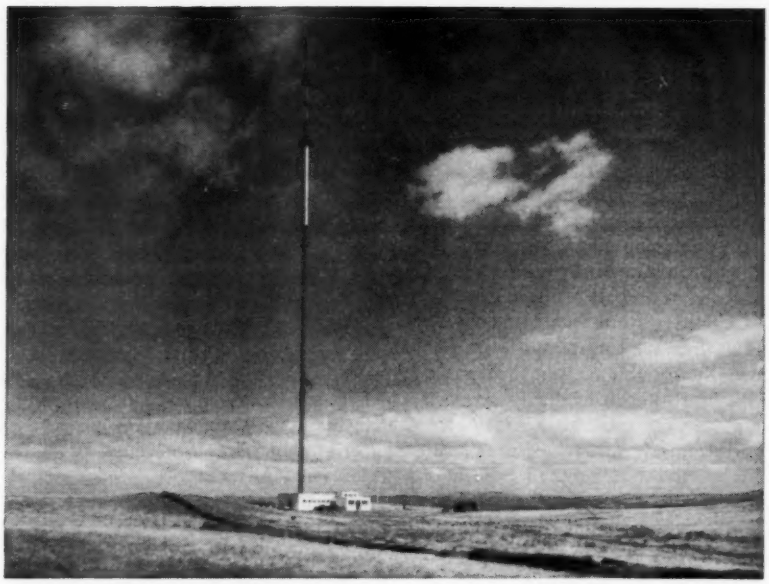
In these cases it is essential to choose a site at which the received signal strength is adequate. This has to be great enough to overcome interference, either from other stations radiating in the same channel or from natural or man-made static, including ignition, diathermy or even intermodulation products generated on the transmitting site. Signals as strong as 1 mV/m at the lower end of Band I have been found to be subject to severe interference at times. A separate receiving site and centimetric link can be used when the transmitting site is not suitable, but they present complications and expense which are to be avoided unless essential.

It follows that television stations have frequently to be erected on the tops of hills, sometimes with very difficult access, and the final choice may be made to minimize the cost of roads, electricity and water supplies, telephone lines, etc. These positions often make the stations prominent landmarks, and the buildings have to be designed to

1 *Crystal Palace television-transmitting station*
The completed tower and transmitting-aerial system

fit in with the landscape. In practice, they must satisfy the aesthetic requirements of the local planning authorities, which may involve stone facing etc., resulting in greatly increased costs. In a built-up area, or on restricted sites, e.g. the Crystal Palace, it may also be necessary to use a self-supporting tower. Figs. 1 and 2 show examples.

Before a choice is made, site tests are needed to determine the relative suitability of possible sites and the gains that can be achieved with masts of different heights. The height gain is, of course, very much dependent on ground contours and may vary considerably in different directions. Since the cost of masts rises more nearly as the square than as the linear function of height, the mast height needed at any given site must be very carefully assessed.



2 *Television and v.h.f. sound broadcasting station at Blaen-Plwyf, Cardiganshire*
A general view looking north-west

Transmitter power and aerial

With a possible site location in mind, the channel and polarization are chosen to give the best received signal, subject to, and causing, the least interference; and the required and permissible e.r.p.'s are calculated for each direction for an assumed mean aerial height, to give the templet for the horizontal radiation pattern. From this, the required mean e.r.p. is calculated.

The e.r.p. that is achieved in practice is given by the product of the transmitter power and the effective aerial gain, i.e. the intrinsic aerial gain less the total of all the power losses in feeder systems and combining units. Since aerials are passive networks neither consuming power nor using valves, and requiring relatively little maintenance, it is economic from the revenue point of view to use the maximum practical aerial gain in conjunction with the lowest transmitter power. From the capital point of view, the cost of the aerial gain has to be balanced against the reduction in cost of transmitters that it permits.

The intrinsic gain of a multi-tier omnidirectional aerial system is approximately proportional to its vertical aperture in wavelengths. On Band I, for which the average wavelength works out at just under 20ft, a high-gain aerial may occupy a very significant proportion of the mast height. Further, as the intrinsic gain is increased, either the mast height has to be increased or the mid-point is lowered, thus reducing any height gain that may apply.

Another difficulty with wide-aperture aerials is that cancellation of the signal can occur at distances of up to a mile or so from the transmitting station, unless special precautions are taken.

In the u.h.f. bands, practical limits to the aerial gain may be set by the number of stacks that can be accommodated on a cantilever support of the required dimensions and rigidity. As the gain is increased, the vertical-radiation pattern becomes more sharply focused. Allowance must be made for tilting of the aerial due to windage on the mast, or even due to uneven expansion in a hot sun. With very-high-gain aerials, the beam is depressed slightly below the horizontal to give the best coverage.

For high-power installations, very high masts and aerial gains become economic; but, for very low-power installations, amplifiers may be cheaper than aerial tiers, so that it is sometimes economic to use a simple aerial with low gain. The cost of the aerial itself is greatly dependent on the horizontal-radiation pattern required and the extent of the scale-model and prototype tests needed. In practice, Band I aerials have intrinsic gains ranging from one to about eight for masts up to 750ft, but the gains of Band V aerials may range from about ten to 30, or more.

Methods of transmitter operation

The balance between the cost of the mast and aerial system on the one hand and the transmitter power on the other will be affected by the method of operating the transmitters. Possible methods are:

1. A single transmitter without a standby
2. A single transmitter capable of reduced power output
3. A single output stage with duplicate low-power stages
4. Main working transmitter and low-power standby
5. Equal-powered working and standby systems
6. Parallel transmitters feeding a single aerial system

7. Two or more parallel transmitters feeding a multiple aerial system.

The method of operation used for the sound transmitters is usually, but not necessarily, the same as that adopted for vision.

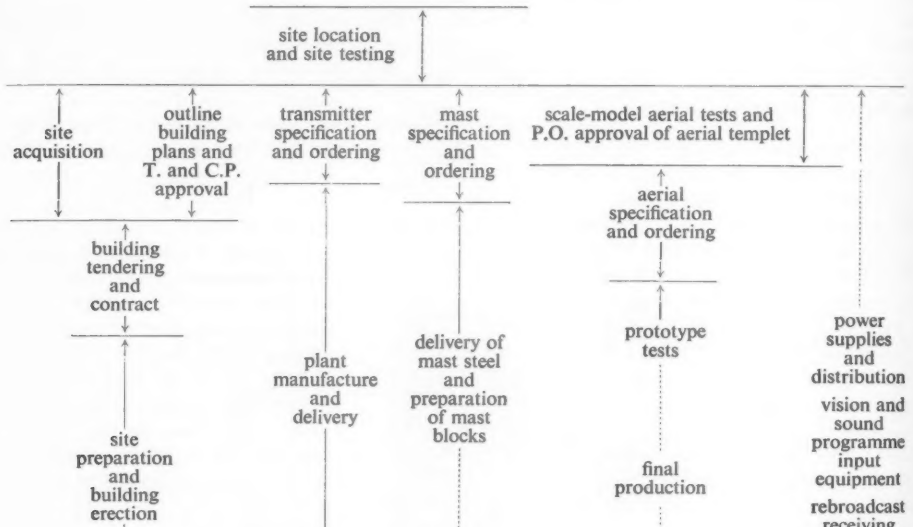
For equipment as complex as a television transmitter, carrying a service, it is normal practice to provide some form of standby transmitter. Also, although breakdowns on aerials should be very rare, they do occur, and when they occur they may take a long time to rectify, particularly in winter. It is therefore advisable to have a duplicate feeder up the mast and a reserve aerial connected to it. If the working aerial is more than a single tier, it is usually possible to split it into two halves and to connect one half to each feeder.

Given the need for a second transmitter and duplicate aerials and feeders, the possibility of independent parallel operation becomes apparent. The relative costs for the different systems will be dependent on the transmitters available at the different power levels and the permissible reduction in signal strength for the standby condition.

For a power reduction on standby of 6dB, which is usually acceptable, it is possible to use either a working transmitter and a standby transmitter of one-quarter the power, or two parallel working transmitters each of half the total required power. The total transmitter cost for the parallel transmitters is then likely to be slightly less than for the working-and-standby system.

If a smaller standby transmitter is used, giving a 10dB reduction in signal strength, the working-and-standby system is likely to be slightly cheaper than the parallel system. In either case, the differences would probably be less than 10% of the transmitter costs, assuming that transmitters of suitable powers are available, and a much smaller percentage of the total station costs.

In certain instances it has been found practical and economic to use as many as four transmitters in parallel, each working into an independent section of the aerial. The power reduction after the first failure is then in the ratio 16 : 9, i.e. less than 3dB.


site location and site testing
site acquisition
outline building plans and T. and C.P. approval
transmitter specification and ordering
mast specification and ordering
scale-model aerial tests and P.O. approval of aerial templet
aerial specification and ordering
building tendering and contract
plant manufacture and delivery
delivery of mast steel and preparation of mast blocks
prototype tests
power supplies and distribution
vision and sound programme input equipment
rebroadcast receiving systems
lines
links
etc.
site preparation and building erection
final production
erection
technical wiring and plant installation, commissioning and testing
aerial erection, lining-up and testing
over-all tests and acceptance trade tests service

3 *General programme for transmitting-station project*

The relatively low signal drop in the event of one fault, and the unlikelihood of two simultaneous faults, sometimes permit staff reductions to be made, when using the parallel systems of operation, without undue risk to the service, and a low- or medium-power station of this type can be arranged to run without staff permanently in attendance.

Building

When the basic decisions have been taken on site, height of mast and power of transmitters, it is possible to proceed with the general planning of the station, and to decide on the staffing arrangements, the type and size of building to be used and the building and site lay-out. Suitable allowances must be made for main power-supply distribution equipment, standby Diesels if needed, and vision and sound input equipment. The requirements of other services may also have to be taken into account, as it frequently happens that the same site will be used for a v.h.f. sound service, and provision may have to be made for possible future expansion.

In designing the building, the lay-out of the technical equipment is relatively straightforward in general terms, though the detailed planning presents scope for ingenuity, particularly in connection with ventilation and valve-cooling systems, and in the simplification of building work needed for floor ducts for wiring and air trunking etc.

If the station has to be manned, one of the first points to settle will be the disposition of the control and monitoring areas in relation to the rest of the operational equipment. They must provide acceptable working conditions of noise and temperature.

It is also necessary to decide what offices and staff amenities will be needed. Even an unattended station will be visited regularly, and staff may be unable to get away because of snow or fog, so that on exposed sites provision must be made for a stay of several days in winter. Adequate stores and workshop facilities are also of importance. The final design has to be both aesthetically pleasing and operationally satisfactory.

Estimate and installation programme

As soon as the general plan of the station is sufficiently clear, an estimate of cost has to be made; and, subject to its approval, specifications and inquiries for tenders can be issued for the major items of equipment.

The capital value of the estimate will vary between wide limits for stations of similar power, on account of differences in masts or towers, forms of building, staff amenities, access roads, initial cost of power supplies, water, etc., and complications of aerial design to give particular radiation patterns.

On the revenue side, the factors which will result in the greatest variations are staffing and programme circuits.

Very close financial control is almost always necessary, and it is most desirable to know at all stages as the work proceeds how the cost is running in relation to the estimate. For this purpose, it is helpful to use a system of records which shows up, immediately they occur, any divergencies (either definite or re-estimated) from the amounts allowed in the original estimate.

The problems of drawing up and implementing an installation programme are similar to those for other types of project. An example of this is shown in Fig. 3. In general, a service target date has to be forecast on the basis of the major determining factors, and it is desirable to work back from there, to establish the necessary dates for each stage of the programme. These must take site conditions into account, as, on exposed hill-tops, mast and aerial work may become uneconomic and possibly impossible in winter, while building work may not be much easier.

In practice, it is rarely possible to complete the building in time for the installation of plant. Some allowance has to be made for the extra time needed for installation in difficult and dirty site conditions. Delays, however, are cumulative, and it is usual to find that the time available before service for the testing of the station as a whole is limited.

Such essentials as training of operating and maintenance staff, preparation of final operating instructions, tabulation of test results, etc. have to be fitted in during the final period before service, at the same time as any 'teething troubles' are being overcome.

The skill of the planning and installation engineer therefore lies not only in his ability to find solutions to technical problems but also in his ability to appreciate in advance where delays and difficulties may arise, and where extra pressure and effort are needed.

Summary

The planning of a television station involves the choice of the most economic combination of site, aerial system and transmitters to give the required field strength throughout the service area, with the maximum reliability and minimum demand for operational staff.

The use of parallel transmitters has many advantages. The problems of preparing and implementing an installation programme are largely common to any similar project and are much dependent on site conditions.

New B.B.C. transmitter at Brookmans Park

THE B.B.C., following its policy of modernization, has ordered a 50kW transmitter for the London station at Brookmans Park to radiate the Light Programme on 1214kc/s. The transmitter, expected early in 1962, is to replace one of the original transmitters—the last of its type still in service—installed in 1929.

The new transmitter, which will be compact, will have three times the over-all efficiency of the old one and will use air-cooling instead of water-cooling for the transmitting valves. High-power classB modulation, having a very low harmonic distortion factor, will be employed.

The Brookmans Park medium-wave Light Programme transmitter serves the London area and parts of the Home Counties. The area is also served on v.h.f. from Wrotham in Kent.

TELEVISION RECORDING

621.395.625.3:621.397.13

Improvements in the quality of telerecordings, culminating in the last year or two in the advent of a successful system of recording television on magnetic tape, have introduced a period of change and experiment in the production of television programmes. More and more are being pre-recorded, and consequently the viewer is seeing less and less live television. This trend, regretted by some, is in line with experience in sound broadcasting, where satisfactory recording systems have been available for many years and where recorded-programme transmissions range from about 50% of the total output of the B.B.C. to over 90% in the case of some broadcasting authorities.

This article is based on the author's lecture to the Electronics and Communications Section of The Institution at Savoy Place on the 19th November 1958. Mr. Redmond is with the British Broadcasting Corporation.

J. REDMOND, MEMBER

UNTIL video tape recorders became available, all telerecordings were made on film by the simple expedient of photographing television pictures displayed on a cathode-ray tube.

FILM TELERECORDING

In film telerecording, the pictures displayed on the cathode-ray tube are photographed by a cine camera which, depending on the system employed, may be virtually indistinguishable from the average motion-picture camera, or may be a much more elaborate mechanism. The recorded film is processed to produce a negative, from which a print is exposed and processed in the usual way. When required, the print is reproduced via a telecine equipment, in which it is scanned to produce a television waveform suitable for transmission to the viewer's receiver.

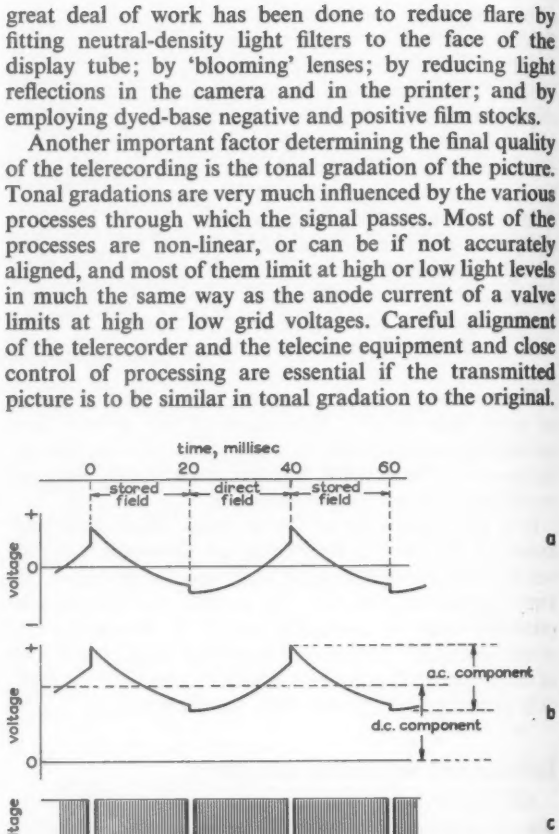
In each of these transfer operations there is some degradation of the quality of the original signal. The principal degradations affect the resolution, the flare and the tonal gradation of the recording.

Degradation

There are losses in sharpness, or resolution, at each stage. Any attempt at equalizing the signal to improve the resolution worsens the signal/noise ratio. In addition, the grain of the display-tube phosphor, of the film stocks and of the telecine scanning tube combine to add the equivalent of noise to the final picture.

Perhaps the worst form of degradation, and the most difficult to reduce, is flare, which is caused by light scatter at the various glass/air and film/air surfaces. A great deal of work has been done to reduce flare by fitting neutral-density light filters to the face of the display tube; by 'blooming' lenses; by reducing light reflections in the camera and in the printer; and by employing dyed-base negative and positive film stocks.

Another important factor determining the final quality of the telerecording is the tonal gradation of the picture. Tonal gradations are very much influenced by the various processes through which the signal passes. Most of the processes are non-linear, or can be if not accurately aligned, and most of them limit at high or low light levels in much the same way as the anode current of a valve limits at high or low grid voltages. Careful alignment of the telerecorder and the telecine equipment and close control of processing are essential if the transmitted picture is to be similar in tonal gradation to the original.



1 *Suppressed-field system: modulation of light output of display tube*

a a.c. component of modulation waveform
b complete modulation waveform
c unmodulated video signal
d modulated video signal
e light output from display tube

Suppressed-field system

First attempts at film telerecording in the United Kingdom were made in 1947, using a standard 35mm cine camera to photograph a picture on a cathode-ray tube. The camera was run at 25 film-frames/sec to bring it into synchronism with the television picture rate. The film was exposed to one television field and blacked out by the camera shutter during the next. During the black-out period, the film was moved on one frame.

Results from the suppressed-field system were poor, particularly in respect of resolution and signal/noise ratio, and a great deal of research went into ways and means of recording every field while at the same time permitting the film to run at 25 frames/sec. Various special cameras were tried, and one in particular was used operationally for a number of years. This camera employed an optically compensated mechanism which made it possible to record a stationary television picture on film which was moving at constant speed. Exposure of the film took place continuously, and therefore all 405 lines were recorded. Its mechanism, however, was elaborate, and the losses introduced by its complicated optical system outweighed the theoretical advantages of being able to record all 405 lines.

Ideally, of course, one wants a camera in which the film can be moved down one frame in the interval between pictures, i.e. in the field blanking period, which lasts 1·4millisec. Reliable camera mechanisms possessing the very high rate of acceleration necessary to achieve this have been difficult to design. It is only in the last few years that 16mm cameras have been produced in which the film can be moved down one frame in little more than 1·4millisec. The problem is even more acute in the case of 35mm film, since the frame dimensions and the mass of the film are so much greater, and a successful 35mm camera has not yet been produced with adequate acceleration.

Stored-field system

A happy solution to the problem was suggested by Angel.* In his stored-field system, a standard cine camera is used, as in the suppressed-field system, but the display tube has a long-persistence-phosphor screen with a decay time of about the same duration as a television field. The camera shutter opens at the beginning of one field (the direct field), and the whole of that field is recorded as it is displayed, together with the previous field which has been 'stored' on the display tube by the long-persistence phosphor. The camera shutter then closes and the film is advanced one frame while the next field (the stored field) is being displayed on the tube.

Because of the long decay time of the phosphor, the lastlines of the direct field must be brighter than the first if the film is to receive even exposure. For the same reason, the first lines of the stored field are made brighter than the last by being drawn on the tube one-fiftieth of a second before the shutter opens (see Fig. 1). By this technique, every television field can be recorded in a camera whose shutter is open only every second field.

2 *35mm rapid-pull-down system*

Rapid-pull-down mechanisms

A logical extension of the stored-field principle is to employ a camera having a faster pull-down mechanism. Since the shutter is open longer, the film is exposed for a longer period, a higher average brightness of the display tube is obtained, and it is possible to use less-sensitive but finer-grain film having better resolving powers and introducing less noise. 35mm equipment of this type is now in service (see Fig. 2). The camera mechanism has a pull-down time of 3½millisec. The display tube is coated with a willemite phosphor.

Nowadays, when care has been taken in the design and manufacture of the equipment and where there is rigid control of each stage in the recording process, including the negative and positive film processing, it is regularly possible to achieve very-high-quality telerecordings on 35mm film. 16mm film telerecordings are of lower quality, but even so are used considerably throughout the world because of their low cost.

MAGNETIC TELERECORDING

In 1958 the first video tape recorders came into service in Britain and elsewhere, after extended field trials of prototypes by the major network companies in the United States.

* ANGEL, Y.: 'Considérations sur le fonctionnement des vidigraphes', *Onde Electrique*, December 1954, 34, no. 333, p. 958

In sound broadcasting, magnetic-tape recorders using plastic tape have been in common use since about the end of the last war. They are noted for their high fidelity and are extremely popular with users because the tape is easily handled and can be replayed at once without processing. There is also the economy of being able to use the tape many times. It has always been obvious that tape would have similar advantages in television, and for some years now a great deal of effort has been put into the development of video tape recorders.

In the transition from recording and replaying signals having frequencies between about 50 and 15000c/s, to signals having frequencies from zero to 3Mc/s or more, designers have quite obviously been faced with some difficult problems concerning particularly the bandwidth, the tape, and the speed constancy of the recorder.

Bandwidth

A successful video tape recorder must be capable of handling frequencies from zero to 3Mc/s if it is to be used on British television standards, and even higher frequencies if it is to be used on American or C.C.I.R. standards. When recording such a wide frequency range, there are two main problems:

1. At the high-frequency end of the spectrum, the problem concerns the shortest useful recorded wavelength. The recorded wavelength is equal to the tape speed divided by the frequency. For 3Mc/s and a tape speed of 15in./s, the recorded wavelength is 5 microinches. It is not yet possible to make heads which can deal with such short wavelengths, and the velocity of the tape relative to the recording head must be increased above that for sound-recording speeds, to enable the very high frequencies to be recorded and reproduced
2. At the low-frequency end of the spectrum, the situation is entirely different. At low frequencies, the flux recorded on the tape changes very slowly along the length of the tape, and at these long wavelengths the resultant voltage output is low and signal/noise ratios are poor.

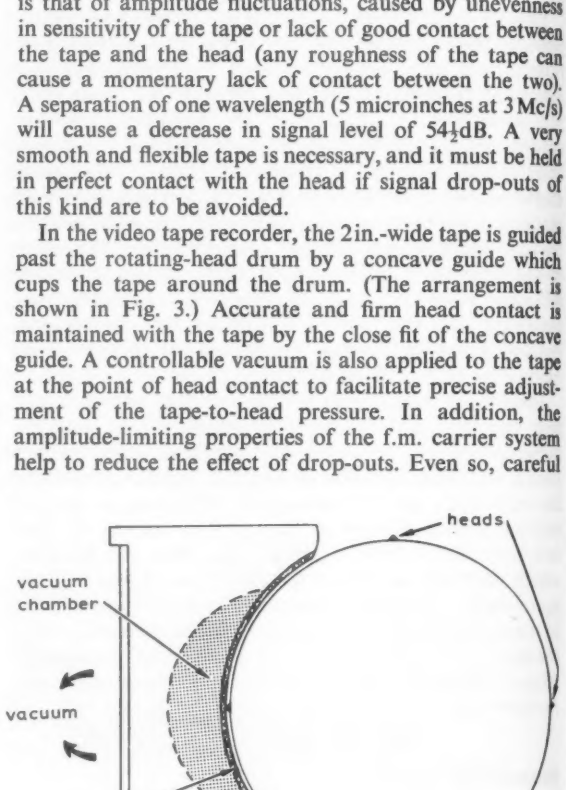
It can be seen, therefore, that the requirements at the upper and lower ends of the frequency spectrum are incompatible. A head designed to have a very small gap width and to be efficient at very short wavelengths must be small physically and, since there is space for only a few turns of wire, it must have a low inductance. It is inevitably inefficient at very long wavelengths.

In video tape recording, a frequency-modulated carrier is used, making it possible to work within a bandwidth of $\frac{1}{2}$–$5\frac{1}{2}$Mc/s. This solves the problem of l.f. response and simplifies head design. On the other hand, it calls for even greater relative tape-to-head velocities to record and reproduce the higher frequencies. These are achieved by using a 2in.-wide tape running at a normal sound-recording speed of 15in./s, and a head unit on which four recording or reproducing heads are mounted at the outer circumference of a rotating disc. The heads are rotated at 15000r.p.m., scanning the tape transversely, and the writing speed, or relative tape-to-head velocity, is 1500in./s. By this combination of high writing speed and a frequency-modulated carrier system, the equipment designers have overcome the difficulties of recording both the high and the low frequencies.

Tape

Another important problem in magnetic telerecording is that of amplitude fluctuations, caused by unevenness in sensitivity of the tape or lack of good contact between the tape and the head (any roughness of the tape can cause a momentary lack of contact between the two). A separation of one wavelength (5 microinches at 3Mc/s) will cause a decrease in signal level of $54\frac{1}{2}$dB. A very smooth and flexible tape is necessary, and it must be held in perfect contact with the head if signal drop-outs of this kind are to be avoided.

In the video tape recorder, the 2in.-wide tape is guided past the rotating-head drum by a concave guide which cups the tape around the drum. (The arrangement is shown in Fig. 3.) Accurate and firm head contact is maintained with the tape by the close fit of the concave guide. A controllable vacuum is also applied to the tape at the point of head contact to facilitate precise adjustment of the tape-to-head pressure. In addition, the amplitude-limiting properties of the f.m. carrier system help to reduce the effect of drop-outs. Even so, careful



3 *Video tape recording drum*
Cross-sectional view of drum, with concave guide and tape

selection of tapes is still necessary, and they are not usually at their best until they have been polished a few times by the recording and reproducing heads.

Speed constancy

The other main problem in magnetic telerecording has been speed constancy. Any change in tape speed or

head speed, or both if they both move, results in time-displacement errors in the output signal. These timing errors can produce a horizontal weaving of the viewer's picture. The amount of weave visible to the viewer will depend on the type of line time-base in his receiver and is most obvious on 'flywheel sync' receivers, i.e. on receivers in which the line time-base responds only slowly to changes in timing of the incoming line-synchronizing signals.

In the video tape recorders now in use, a complex servo system maintains a very high order of speed constancy, and normally there is very little picture weave visible on the average receiver.

CHOICE OF METHOD

The major disadvantage in magnetic telerecording is that the synchronizing signals are recorded with the picture. This causes difficulties in editing, in mixing with other programme sources and in replaying the recording on other transmission standards. The most serious difficulty is that of transmission standards, particularly in the United Kingdom, as our 405-line 50-field standard is not employed anywhere else in the world.

There are two possible alternatives:

Either recordings can be made on tape via a standards convertor, which is simply a television camera working on one standard and televising a picture on a cathode-ray tube adjusted to another

Or one can record on film, which is the universal standards convertor and which also has the virtues of easy examination and editing at the receiving end.

In deciding whether to record on tape or film, cost and quality are usually the deciding factors.

As far as expense is concerned, 35mm film costs about £180 per hour for one negative and one print, or £230 per hour with a high-quality separate magnetic sound track. 16mm film costs about £50 per hour, or £60 per hour with a high-quality sound track. Additional prints of 35mm film cost about £60 per hour and of 16mm film about £25 per hour. Video tape costs £120 per hour but can be reused many times if it is not cut and rejoined too often.

As far as quality is concerned, video tape recordings are slightly superior to 35mm film recordings made on the best equipment, and substantially superior to 16mm recordings.

B.B.C. experience

Before video tape recorders came into service, the B.B.C. used 35mm film for all domestic recordings other than sport and news, for which 16mm film was used. 16mm film was also used for recording programmes to be sent abroad and is still used for this purpose.

Most domestic recordings are now being made on video tape, and 35mm film is now employed mainly for recordings which require considerable editing or which have to be stored for a long time. It seems probable that film, in 35mm form, will continue to be used domestically in small quantities for such purposes; and in 16mm form will continue to be used for some considerable time for oversea recordings, because of its cheapness and convenience—particularly when a number of prints are required—and because of the universal availability of 16mm telecine equipments. The demand for recordings from Commonwealth and other English-speaking countries is increasing rapidly, and the next few years will see an intensive effort to improve the quality of 16mm recordings for this type of programme.

In the main, however, it seems likely that when a television organization needs a recorder it will almost inevitably buy video tape equipment rather than film equipment. The advantages are obvious: immediate playback (no need for processing), good quality, and lower costs since the tape can be used again and again. It seems probable, therefore, that the use of tape in telerecording will continue to increase at the expense of film.

Summary

First experiments in film telerecording in the United Kingdom began in 1947, and steady progress has been made in improving quality since that date. Successful video tape recorders were introduced into service in 1958 after a considerable amount of development work. Since then, because of the improved quality, the convenience and the economy, tape has begun to supersede film as a television recording medium.

NEW DIVISION AT HARWELL

A NEW division—the Solid-State Physics Division—has been formed at the Atomic Energy Research Establishment, Harwell, to carry out basic research into the structure and behaviour of solids.

Better understanding of the structure and properties of solids is of great importance to the Authority. The Harwell nuclear reactors, in particular the research reactor Bepo and the material-testing reactors Dido and Pluto, play a significant part in studies of the properties and behaviour of materials.

The programmes of work fall broadly into two parts: first, the basic and applied studies of the effects of nuclear radiation on materials of importance in reactor technology, which will remain under the control of existing Harwell divisions; and secondly, the more basic studies of the behaviour of solids in general, without reference to any particular application, which will be the special concern of the Solid-State Physics Division.

Included in the programme of the new division will be: studies of the formation and nature of defects in crystals; other physical properties of metals, alloys and magnetic materials; and fundamental crystal physics, using extracted beams of neutrons from the reactors.

Anglo-Swedish submarine telephone cable

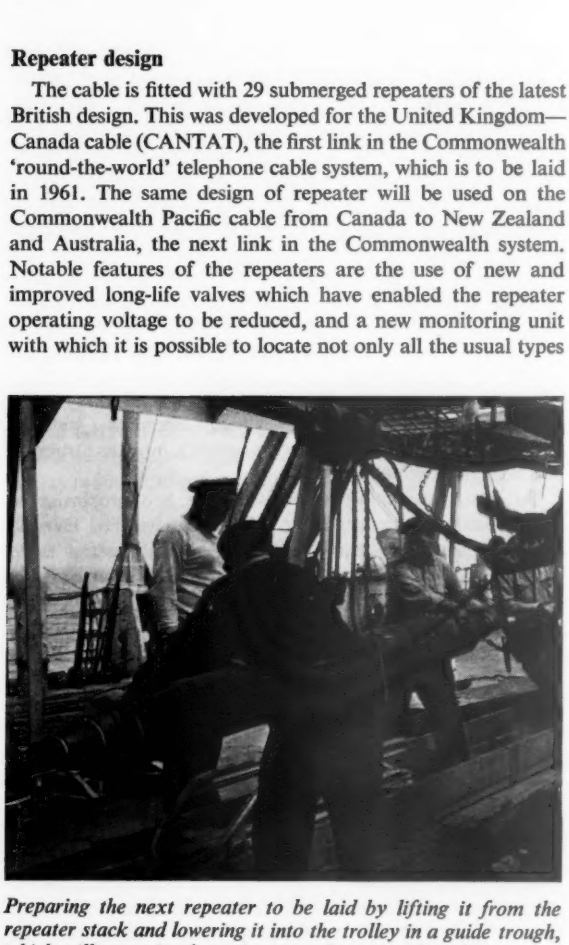
On the 17th June 1960, the final splice was made in a new submarine telephone cable between the United Kingdom and Sweden, the first direct telephone cable between the two countries.

It will provide 60 telephone circuits of C.C.I.T.T. quality and is the longest submarine cable in the world equipped with submerged repeaters for two-way operation. It is a joint project by the United Kingdom Post Office and the Royal Board of Swedish Telecommunications. The cable, repeaters and terminal equipment are of British design and were manufactured by British contractors.

At the United Kingdom end, the terminal equipment is installed in a new repeater station at Middlesbrough, Yorkshire; in Sweden the terminal equipment is at Göteborg. The submarine cable route is from Marske, about 10 miles east of Middlesbrough, to Sandvik, some 10 miles from Göteborg. The submarine section is about 510n.m. long, the over-all length between the terminal stations being about 527n.m.

Repeater design

The cable is fitted with 29 submerged repeaters of the latest British design. This was developed for the United Kingdom—Canada cable (CANTAT), the first link in the Commonwealth 'round-the-world' telephone cable system, which is to be laid in 1961. The same design of repeater will be used on the Commonwealth Pacific cable from Canada to New Zealand and Australia, the next link in the Commonwealth system. Notable features of the repeaters are the use of new and improved long-life valves which have enabled the repeater operating voltage to be reduced, and a new monitoring unit with which it is possible to locate not only all the usual types of fault but also, for the first time in a British repeater, the source of a wideband noise fault.



Preparing the next repeater to be laid by lifting it from the repeater stack and lowering it into the trolley in a guide trough, which will carry it aft to the stern sheave for launching

The repeater characteristics have been designed to meet the requirements for the new British lightweight armourless cable to be used for the deep-water sections of the Commonwealth system. The cable on the United Kingdom—Sweden route is conventionally armoured to provide the mechanical protection needed for a shallow-water route, but the internal construction of the cable has been modified so that its impedance and loss/frequency characteristics are similar to those of lightweight cable.

This simulation of the characteristics of lightweight cable has been achieved by the use of a composite centre conductor comprising a core of stranded steel wires surrounded by an outer longitudinal copper tape enclosed on the stranded core using a box seam joint. Conventional polythene dielectric insulation with an outer diameter of 0·62in. is used, and the outer conductor is six helical copper tapes with an overlapped copper binding tape. Most of the cable is armoured with 2s.w.g. mild-steel wire, although about 100n.m. in deeper water is armoured with 6 s.w.g. mild-steel wire.

Terminal equipment

The terminal equipment assembles the 60 circuits from five basic 12-circuit groups (60–108kc/s) into the frequency bands 60–300kc/s for transmission in the Göteborg—Middlesbrough direction and 360–608kc/s for the reverse direction. The latter includes a band of 8kc/s used for repeater monitoring.

Power-feeding equipment maintains a constant direct current to the cable, regulated to within $\pm 1\%$, to energize the repeaters. Since the cable system length is short relative to the design capabilities of the system, the whole of the power is fed from the Middlesbrough terminal, the total line voltage being about 3500 volts.

From Middlesbrough the circuits in the new cable are extended to London in carrier and coaxial cables. From Göteborg the circuits are extended to Stockholm by coaxial cable. The London—Stockholm 12-circuit groups are provided in this way without translation to audio frequency at intermediate points.

Cable-laying

The Post Office cable ship *Monarch* laid some 490n.m. of the main cable, including 28 submerged repeaters, between the 10th and 15th June 1960. Shore-ends at Marske and Sandvik had been laid in advance by the smaller cable ship *Ariel*. The link was completed by *Ariel* laying some 16n.m. of cable, including the 29th repeater in shallow water at the Swedish end of the route, and making the final splice on the 17th June.

The new cable is another link in the extensive network of submarine cable between the United Kingdom and the rest of Europe. It will provide a valuable direct route to meet the ever-increasing demands for telephone and telegraph facilities between this country and Sweden and neighbouring countries.

INSTITUTION COUNCIL MEETING, 15th SEPTEMBER 1960

THE following summary of reports received and decisions reached by the Council of The Institution at their meeting on the 15th September 1960 is issued on the authority of the President in a form approved by the Council. It will be understood that this report does not purport to be a complete account of the matters discussed at the meetings, as some items are to be the subject of further discussion by the Council.

Sir Arthur P. M. Fleming, C.B.E., D.Eng., LL.D., Past-President

On opening the meeting, the President referred to the death earlier in the week of Sir Arthur Fleming, PAST-PRESIDENT, an Honorary Member and Faraday Medallist of The Institution. On behalf of the Council, he expressed their deep sympathy with the family and, in tribute to Sir Arthur's memory, asked the members of the Council present to stand in silence. (An obituary will appear in a forthcoming issue of the *Journal*.)

Membership

The Council gave final confirmation of the election of those candidates whose names had been published with the July 1960 *Journal*, to become effective from the 1st September 1960. Taking these into account, the total membership on the 15th September was 46619.

British Conference on Automation and Computation

On the recommendation of the General Purposes Committee, the Council accepted a proposal for modifying the constitution of the B.C.A.C., of which The Institution is a member body. The present structure of the Conference, comprising three autonomous Groups and a co-ordinating General Committee, has been found in practice to be unwieldy and time-consuming, particularly where participation in the work of international organizations is concerned. In the Committee's view, the proposed new constitution, under which the three Groups would be wound up and replaced by a central Council to handle the affairs and activities of the Conference as a whole, would substantially increase the efficacy of the Conference.

Sub-Centre Chairmen at Council meetings

Both the General Purposes Committee and the Finance Committee supported a proposal that Sub-Centre Chairmen attending Council meetings as observers should have the expenses incurred in such attendance met by The Institution, and this was approved by the Council.

The Institution of Chemical Engineers

Support was given to a recommendation that The Institution of Chemical Engineers should be invited to send an observer to the Commonwealth Engineering Conference in Canada in September 1962, pending their election to the Conference, which will be considered at that time.

London Graduate and Student Section

Dr. H. G. Taylor was appointed to represent the new Council on the London Graduate and Student Section Committee in the place of Mr. G. Millington, whose term of office expired on the 30th September 1960.

Also discussed were ways and means of enabling Council members to maintain a closer contact with the activities and affairs of the Section, and a number of suggestions to this end were adopted.

Graduate and Student Section activities

The Council received with interest a review of Graduate and Student Section activities during the 1959–60 Session. This revealed a generally satisfactory state of affairs, although some comment was made on the low attendance figures at meetings.

Henry Nimmo Prize

On behalf of the Chairman of the Examinations Committee, Prof. M. W. Humphrey Davies presented a recommendation of the Committee that the winner of the Henry Nimmo Prize should receive not less than five guineas of the total of 20 guineas in the form of books or instruments of his choice, and the remainder as a cheque. It was explained that Mrs. Nimmo wished the greater part of the Prize to be awarded as a cheque so that the Student might use it to meet his own particular needs—for instance, in travelling to visit places of interest in connection with his work. The Council approved this proposal.

Graduates in physics

The Council accepted a further recommendation of the Examinations Committee that a degree in physics should be approved as a higher qualification for the purposes of Bye-law 12(b)(i). The present requirement that graduates in physics should take further courses and pass certain parts of the Institution Examination, if it was their intention to become electrical engineers, was felt to be a deterrent in many cases. At a later stage, when they could satisfy the other requirements for Associate Membership and their physics degrees would be accepted under the present Regulations, many of them were still unwilling to submit an application for membership.

The recommendations now accepted by the Council allowed such men to be proposed for Graduateship, with the safeguards mentioned in Bye-law 15, and put them in the same position as graduates in electrical engineering, subject always to their meeting the requirements of Bye-law 12(b)(iii) before they could be elected to Associate Membership.

Scholarships

The Council approved the recommendations of the Scholarships Committee for the award of scholarships for 1960.

Special Advisory Committee

The Council received the full and final report of the Special Advisory Committee and decided that it should be issued to Corporate members, Associates, and members of the Graduate and Student Section Committees, and that copies should be made available to other members of The Institution on request.

Code of Practice on Earthing in Nigeria

It was noted that a copy of the Code of Practice on Earthing in Nigeria, as now published, had been received from the West African Joint Group.

Television link between France and North Africa

FRANCIS ANGUERA*

SINCE the 14th July 1960, Radiodiffusion-Télévision Française have operated a television link between the Pyrénées and Algeria. The link is still experimental—the French programme being transmitted only four evenings a week—and will remain so until better knowledge of the annual characteristics of fading enables the final equipment to be designed.

Transmission paths

As shown in Fig. 1, the link comprises two paths, roughly along the 2·7°E. line of longitude. The first, 300km long, connects Fon Frède (Pyrénées-Orientales, France, 1094m above sea level) to Puig Mayor (Majorca, Balearic Islands, 1445m). The second, 350km long, links Puig Mayor to Algiers (400m above sea level).

Profiles of both paths are shown in Fig. 2 for standard atmospheric conditions (ratio of the Earth's apparent radius to the actual radius taken as 4/3). The profile of the first path shows the obstruction presented to the beam by a mountain peak near Tordera, in Spain, 90km from Fon Frède. Although the exact height of this peak is not known, it is apparent that the process of transmission can be only that of diffraction. The profile of the second path shows that the Earth's surface obstructs the beam for about 92km: the transmission in such conditions is based on the phenomenon of tropospheric scatter.

Equipment

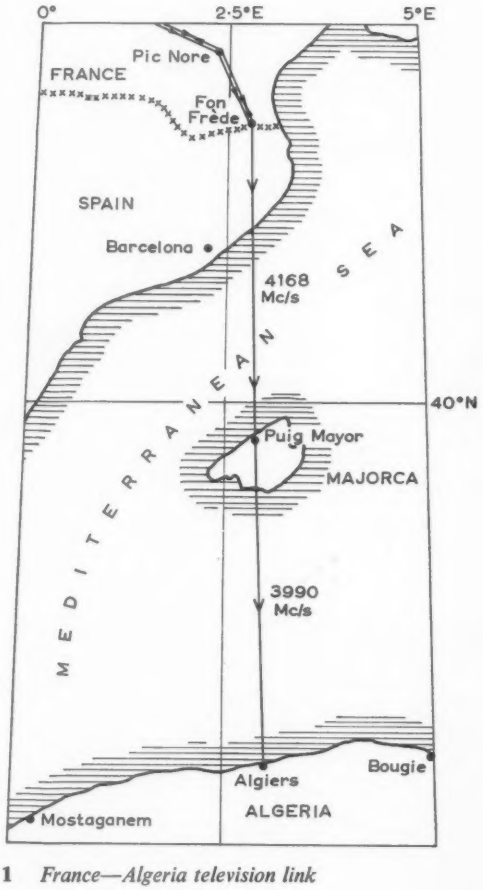
The centre frequencies of the transmitted bands are 4198 and 3990Mc/s for the first and second paths, respectively. The modulation system used is f.m., with strong pre-emphasis at high frequencies. The video bandwidth is about 5Mc/s. The transmitter power of 500 watts is provided by a two-cavity water-cooled klystron amplifier excited by a 10watt stage using two EC 158 triodes in parallel.

Reception is by a space-diversity system, combined at intermediate frequency, using crystal mixers having noise figures of 10dB. The aerials are 6m-diameter paraboloids. There is no demodulation at Puig Mayor, the intermediate point.

* Monsieur Anguera is with Radiodiffusion-Télévision Française

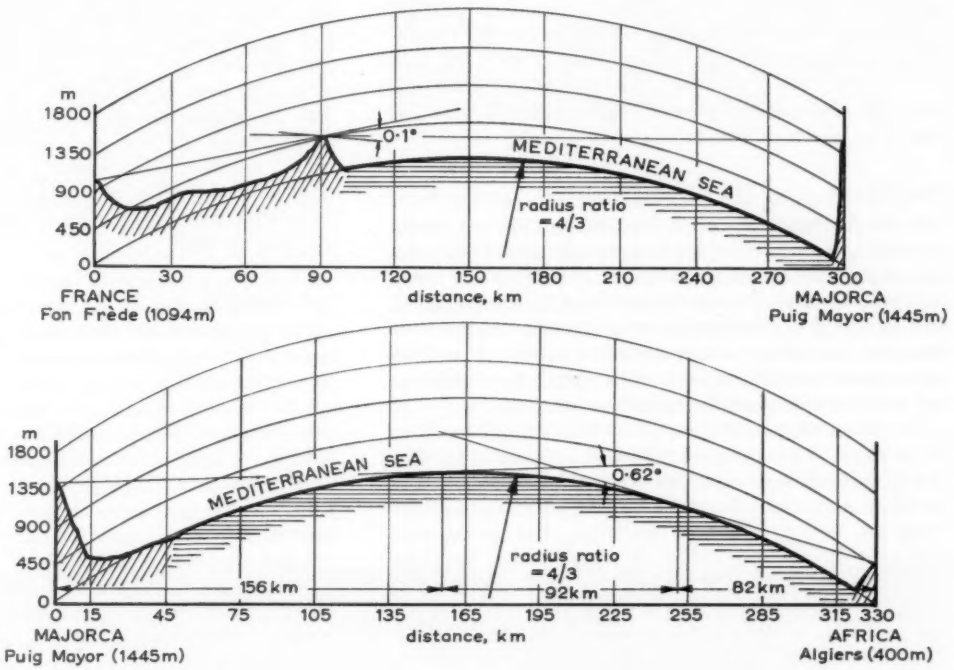
Results

The first experimental results are slightly better than were predicted by theory. The levels of the received signals on the more difficult path, the second, measured by the monthly median of the hourly medians, were as follows: March



1 *France—Algeria television link*

−62dBm; April −56; May −51; June −46; and July and August steadying at about −36dBm. Around these values, the hourly medians are distributed according to a log-normal distribution with a standard deviation of about 11dB.



2 *Profiles of the two paths*

Short-term fading is sufficiently out of correlation on the receiving paraboloids to permit the successful use of the link from March to July. Slight continuous selective fadings were observed by spectrum analysis, but these had no effect on the over-all picture quality, which is very high.

Predicted improvements and expected results

The results obtained during the summer months correspond to attenuations only slightly greater than those encountered in line-of-sight paths. To explain this it must be stated that the median value of the ratio of the apparent to the actual Earth's radius was greater than 2·5 during July 1960.

The figures are in accordance with those obtained from other observations made over the Mediterranean Sea (e.g. by F.T.L. between Sardinia and Minorca), and from the statistical results now known by us we can predict a slow deterioration during the autumn, particularly on the second path—Majorca to Algiers.

The most probable effect will be frequent short-term fadings during the months November to February.

Since their effect on the reliability of the link is not correlated with their statistical distribution but depends on their own features, it would not be advisable to anticipate the experimental results. It can, however, be assumed that a great step towards good annual reliability of performance will have been taken when the improvements listed below have been made:

1. Increase the diameter of paraboloids (a 9m-diameter paraboloid possibly for the worse path)
2. Increase the transmitter power and frequency swing by using three-cavity klystrons
3. Increase the order of diversity by simultaneous frequency and space diversities
4. Reduce the receiver noise, and consequently the threshold of operation of the limiter, which at present is about −83dBm.

From these improvements it would be reasonable to expect an over-all gain of more than 15dB with respect to the present medians.

More automatic telephone exchanges

THE British Post Office reports that, during the first six months of this year, 53 manually operated telephone exchanges were converted to automatic working. In the last six months of the year, the Post Office is planning to convert another 65, an average rate of about two exchanges a week.

The number of manual exchanges still working at the end of June was 886.

THE NEW LECTURE THEATRE AND FARADAY ROOM AT SAVOY PLACE

THE reconstruction of the Lecture Theatre and a number of the rooms on the ground floor at Savoy Place has been successfully concluded, and members may well take pleasure in the result. Visitors to meetings held in the Lecture Theatre during last session will have seen one stage in the work; now it is finished there is an added spaciousness which the new side wings and galleries provide. Some details of what has been done may be of interest.

The new look

Of the Theatre in its previous form only the mahogany panelling remains, but with a freshened surface: the well known portraits are still there, but they have now been mounted in recesses in the architecture and lit from concealed light sources. The new benches for the President and lecturer were seen last winter; now the temporary suspended scaffolding has gone, to reveal a reconstructed ceiling with new lighting and designed to improve the acoustics of the hall.

The old seating has gone, and in its place some 500 modern tip-up seats stand in the room previously occupied by benches of a far less comfortable pattern, seating about 400, and now the addition of over 100 seats in the new wings and galleries brings the total to 610. New ventilating plant, giving what may now be properly called air conditioning, has been installed. The facilities for authors and speakers have been improved, particularly by a new projection room with full provision for cinematograph and television equipment.

The cumulative effect of all these changes has been to establish a greatly improved sense of contact between author and audience: indeed, a new, if indefinable, atmosphere has come into being—to an extent not foreseen when the individual changes were planned.

Faraday Room

A new and additional meeting room, to be known as the Faraday Room, has been built on the west side of the building, taking the place of the old Council Room. A former narrow corridor has been opened up. The west entrance from the street has been rearranged to give access to this room and to the enlarged Theatre, and a new and faster automatic lift has been installed.

When used alone, the Faraday Room can seat an audience of 140, but by an ingenious plan its side wall can be raised over about half its length, making the Faraday Room and the Lecture Theatre physically continuous. There will often be occasions when this way of achieving a single large audience will be desirable, and the speech-reinforcement and eventual television facilities have been designed in such a way that those in the Faraday Room will be fully in touch with the proceedings in the Theatre proper. This movable partition is soundproof; and, when it is lowered, meetings can proceed independently in both locations.

The planning of the new rooms, and their equipment behind the scenes, have been the subject of much thought by the Building Committee and the staff of The Institution, the architect, and the consulting engineers. A great deal of skilful work has been carried out by the builders and allied trades, the heating and air-conditioning installers, the electricians, and by various teams of other specialists concerned, for example, with the lifts, the sound-reinforcement and relaying equipment, and fire precautions. All this has been done while The Institution remained in occupation, and although inconvenience will have been suffered from time to time by visiting members, and conditions for the staff have been far from ideal, there has been a great financial saving to The Institution, since the renting of alternative accommodation has been avoided.

Any regrets?

Some members may feel regret at the disappearance of some of the distinguishing features of the old Theatre, with its solemn panelling, heavily coffered and gilded ceiling, and monastically simple seating. In spite of the detailed improvements which were introduced from time to time, the appearance of the Theatre had remained much the same as it was when reconstructed after our taking over the building in 1909. It had been brightened by the powerful laylights and cornice lighting and the portraits of our famous pioneers, but it retained a sombre, though certainly a dignified, appearance.

The original ventilation by Tobin tubes in the side walls, with a roof outlet, had been boosted by a fan with filter and heater, and an extract fan had been connected to grilles cut into the floor; but even so the atmosphere became stuffy at a full meeting and often chilly at a small one in winter. The lantern operator had a tiny cell in the wall thickness over the middle door.

To make room for more seats, much structural work was required, including the provision of a new floor set at a lower level, and with a different slope, and the cutting of 30 ft-wide recesses in three of the main walls. This required the insertion of heavy steel frames to carry the load above. By this means, the lecturer's bench has been set back into a space previously occupied by a corridor at the rear of the Theatre, and the new east and west wings and galleries fill what were formerly open areas on either side; also there is the facility, already described, for the west wing to be opened into the new Faraday Room. On the east of the building, what were previously the Faraday and Heaviside Rooms are being merged to form the new Council Room, with access to the Theatre via the north corridor. A new projection room has been formed at the level of the Library landing, and suitable portholes aligned onto the screen have been cut in the south wall.

Air conditioning

The ventilating plant has been entirely renewed: as there was not enough room in the basement, the larger fans and filters are housed above the new third floor. The Plenum fan delivers air by a duct to heating and cooling coils on the Theatre roof, and it is then led down beside the new wings to

inlet grilles above the galleries, adjustable louvres making it possible to distribute the air uniformly. The galleries and wings themselves have separate and smaller air inlets.

As before, the air is extracted partly through one large grille in the centre of the roof, and at floor level by apertures placed in the stair risers, against the side walls, and under the platform, so that warmed air can be displaced to the lower levels in winter. A second fan exhausts the air, which, by means of remotely controlled dampers, may be either discharged or recirculated through the filter to save heating or cooling losses before meetings begin. Conditions in the Theatre are automatically controlled, the air being heated in winter and cooled in warm weather, as may be necessary.

There are two separate and smaller air-conditioning plants, one serving the new Kelvin Room (formerly the Tea Room) and the Faraday Room, and another the new Council Room and suite of Committee Rooms. These small plants will not only ventilate the various rooms on the ground floor during large gatherings, but will also add to the convenience of the members of the many committees that work for long hours behind soundproof windows in these rooms; it will not be necessary to run the main plant for this purpose.

Space has been found for a 20 ton refrigerating plant in the basement with a forced-draught cooling tower on the roof. It is big enough to cool the air entering the Theatre by 12° F and so to absorb most of the internal heat gains from lighting and full seating, which could otherwise cause a rise in temperature of as much as 15° F. When the Theatre is not in use, the cooling can be switched to the plants ventilating the meeting rooms by day, and throughout the summer.

There is provision for a second refrigerating machine to be added, if it is found desirable for large conventions held in the summer. The thermal-storage heating system installed in 1936 has been overhauled and augmented by a third storage cylinder to provide a reserve of hot water for the central heating and air conditioning for meetings on cold days.

Improved facilities

The facilities for meetings have been carefully studied to benefit the lecturers and audiences, not forgetting the staff who have to prepare the meetings and assist during them.

All the controls for lighting, sound reproduction, and heating and ventilating are grouped in the new projection room, with certain controls duplicated at the Secretary's position on the Chairman's bench in the Theatre. Simplicity in operation and control has been achieved by incorporating ingenious and sometimes complex circuit arrangements, too involved to detail in an article of this nature. Ducts have been laid in the new floors to take future cables, which may be required for television relaying to overflow meetings in any of the large rooms of the building, or displaying to all the

The new Lecture Theatre at Savoy Place

audience demonstrations or phenomena which could otherwise be seen by only a few.

Lighting

The Theatre has a new lantern screen with a permanent blackboard below it, which are concealed when not in use by a decorative screen. Under the control of pushbuttons, this can be raised or lowered. It is faced with hide and bears in its centre a reproduction of The Institution's coat of arms, worked as a tapestry. This was given by a Corporate member who, having taken up grospoint as a hobby, worked it himself last autumn. It is lit by a projector in the ceiling, which is turned off by a limit switch as soon as the screen starts to rise. The two benches on the platform, and their occupants, are emphasized by other directional lighting concealed in the new ceiling.

General lighting is provided by groups of opal-glass tubes and flush-mounted projectors, giving a level of light sufficient for the audience to read their printed copies of the papers in comfort. In this example of direct lighting by tungsten lamps, the wattage is rather lower than that of the previous fluorescent tubes in the laylights.

The pleasant cornice lighting has been retained in a new installation of hot-cathode fluorescent lamps, and the lighting can be controlled either from the projection room or at floor level near the Theatre door. Dimming is controlled by a new multicircuit electronic equipment. Each controlled circuit can be preset for intensity: normally the ceiling lighting will dim to extinction when a slide is to be shown and the cornice lighting will be reduced to a glimmer. Additional pushbuttons enable the lighting to be held at any brightness over the dimming range or to be put out completely.

In the Faraday Room, rather simpler lighting can be dimmed by a local control at the lantern operating point. If the Faraday Room and the Theatre are operating as one, the lighting of both is controlled in parallel. In both locations, battery-operated emergency lighting of the usual design for public buildings has been provided.

Projection room

The projection room itself is equipped with six portholes arranged for a $3\frac{1}{4} \times 3\frac{1}{4}$in. slide projector, a 2in. slide projector and a 16mm cinema sound-film projector. A 35mm cine projector can be accommodated if required. One port has been designed for eventual use with a television camera, and another to permit large-screen television projection when this becomes technically feasible. Ducts have been provided so that other television cameras can be used elsewhere in the Theatre for shooting at different angles, and the resulting signals can be reproduced on monitor receivers in many other parts of the building.

The sound-reinforcing equipment has not only been rearranged in the Theatre but has also been extended throughout most of the building, and provision has been made for relaying to or from any of the public rooms, including the new emergency meeting room and refectory on the top floor. In the Theatre, the line-source loudspeakers have been redesigned and put in the most effective positions as determined by practical tests. Cable ducts for these and other new equipment are accommodated under the Theatre floor: some of the seats are wired for deaf-aid equipment, and all can be equipped for a simultaneous translation service, should this be required in the future.

A range of a.c. supplies, and a variable-voltage d.c. supply from rectifier equipment, have been brought onto the platform for demonstrations in the Theatre. Under a changeover scheme, the London Electricity Board have contributed to the conversion of the d.c. equipment remaining in the building to a.c., particularly the lifts, so that the previous public d.c. supply could be withdrawn.

From this brief account it will be realized how extensive are the changes—not all of them visible on the surface—which have been made to some of the public rooms and their equipment.

It now remains for members who are able to do so, to see the results for themselves and, it is hoped, to sample and enjoy these new facilities and the brighter atmosphere their cumulative effect has produced.

REPORT FROM WINFRITH, 1960

THE Atomic Energy Establishment, Winfrith, is the second major establishment in the U.K.A.E.A. Research Group, and is superseding Harwell, the first, as the head unit of the Group. Very close liaison is maintained between these two establishments, the experimental reactor unit at Dounreay and the Industrial Group factories and sites at Risley and Windscale; a daily air service provides a convenient link for senior staff.

In addition to its large and growing volume of research, Winfrith is the location of the Dragon project, in which Austria, Denmark, Norway, Sweden, Switzerland and the United Kingdom, and the six countries of Euratom, are collaborating under the aegis of the European Nuclear Energy Agency.

High-temperature reactors

The Dragon project is essentially a high-temperature gas-cooled reactor experiment designed to test the feasibility of the type and its novel features. Theoretical studies indicate that the concept is potentially a very cheap source of energy, so its progress is being followed with much interest throughout the world.

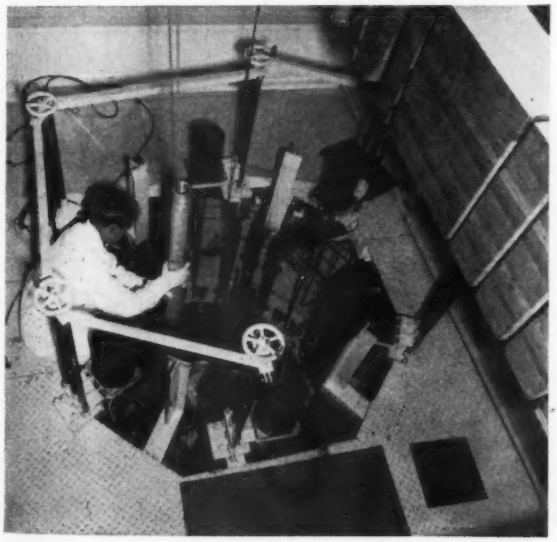
The fuel used is a mixture of fertile thorium, fissile uranium and graphite, and parts of the core will reach temperatures approaching 1500°C; the coolant is helium at 20atm., entering the core at 350°C and leaving it at 750°C; on this basis, the reactor will generate 20MW of heat, but this must be dumped, since Dragon is essentially an experiment, not a power-station reactor. While the thorium itself is stable—i.e.

non-fissile—it is able to absorb neutrons from uranium 235, to become uranium 233, and thus presents interesting possibilities; the core will be loaded with 20 kg of uranium 235 and 135 kg of thorium 232.

To provide data for Dragon and other future high-temperature reactors, the Authority have built the zero-energy reactor Zenith (Fig. 1), in which the core is raised to operating temperature by the passage of heated nitrogen rather than by its own nuclear reaction. This permits closely controlled investigation of reactor physics and the problems of instrumentation at these high temperatures. Zenith went critical on the 19th December 1959 and has already provided a great deal of information for the engineers and physicists of the technical assessment group.

Experimental assemblies

However, the main work of the Establishment is broadly organized on a wide functional basis rather than being directly related to a specific project. Thus there are now a number of experimental assemblies with external neutron sources for detailed studies of the physics of the reactors under construction or envisaged for civil power stations; some of these smaller stacks are part of the British Industries Collaborative Exponential Programme (BICEP), which embraces the industrial consortia and representatives of the shipbuilding interests. From the latter aspect, Winfrith has



1 *Looking into the core of Zenith reactor*

supplied a team to assist in the technical assessment of the schemes and tenders for nuclear marine propulsion submitted to the Ministry of Transport.

Reactors of the Calder Hall type burn uranium 235 and produce plutonium; two special assemblies—Scorpio I and II—have therefore been constructed to study the effect of this mixture of plutonium and uranium in laboratory conditions. The core under investigation is heated by electric 'blankets' and takes 48 hours to reach its maximum temperature of 400°C. Scorpio I is an exponential stack which yields data on the critical sizes of power reactor after various periods of operation, and on the effects of lattice geometry, uranium/plutonium ratio and core temperature. Scorpio II is smaller and subcritical; its data relate to local variations of neutron distribution. Both experiments are contained within steel shells to prevent the release of plutonium in the unlikely event of the failure of a fuel-element can.

Nero is a highly flexible graphite-moderated zero-energy reactor which was first commissioned at Harwell in February 1957, dismantled in October 1959, and re-erected at Winfrith. Its graphite dimensions, lattice geometries, fuel elements and control-rod locations can be varied within wide limits, to yield information on critical sizes, reflector effectiveness, control-system performance and the kinetics of power changes. Nero has now been adapted for oscillator-technique measurements, in which small quantities of a material under investigation are moved in and out of the reactor core (with about 30 sec in the core per cycle) and the effect on the reactor power is measured.

Hector

However, with Nero, this technique can be used only at room temperatures, and thus construction has begun on Hector [heated experimental carbon (graphite) thermal oscillator reactor—one of the few new ones whose name means something obvious]. Unique in that it is possible to reproduce closely in it the conditions appropriate to many different power-reactor designs, it is expected to go critical in 1962. A wide variety of fuels may be used, and the assembly can be heated to 450°C to simulate reactor conditions; but successful measurements are possible only if this temperature does not change by more than 0·003°C/min.

Dimple (deuterium-moderated pile, low energy) has also been moved down from Harwell; this is a low-power thermal reactor with a heavy-water moderator, used for studies on fuel arrays. It began operation at Harwell in August 1954.

Helen is a miniature swimming-pool reactor—a daughter to Harwell's Lido. The fuel assembly consists of parallel-plate assemblies of plutonium–aluminium alloy rods, and the moderator is heavy or light water. It is a subcritical assembly with a neutron source below the tank, but both tank and source have a concrete biological shield, and the whole experiment is contained within a steel shell. Automatic remotely-controlled fission chambers are used for flux scanning (thermal neutrons), and the reactor-physics parameters can be measured for a range of lattice spacings and moderators.

Intense neutron source

Although some of the exponential and subcritical experiments can be driven by simple neutron sources, there is need for a more intense source, and so the 10 kW reactor Nestor will shortly come into service to provide this. It is designed so that five experimental assemblies can be mounted round it (one on top), each being isolated from the reactor by a neutron shutter.

The generation which is expected to follow the high-temperature gas-cooled reactors into commercial service is the fast breeder reactor—which produces more fuel material than it consumes. The early investigations were carried out at Harwell with the zero-energy piles Zephyr and Zeus; these led to the Dounreay station and then to Zebra, an experiment at Winfrith conceived for the study of possible designs for a commercial fast-reactor station with an output in the region of 200 MW.

Control and instrumentation

Behind the reactors themselves lies a vast array of complex investigations into the problems of control and instrumentation posed by the nuclear developments, involving the fullest deployment of current techniques and skills in mechanical and electrical engineering and the daily creation of new ones. At the larger end of the scale, for example, is the problem of positioning fuel-element charge machines weighing many tons with millimetre accuracy, by remote control and in high-temperature conditions. At the other end is the design of accurate head amplifiers and connecting cables, with subminiature components, which will work and remain stable for very long periods at around 500° C.

Industries other than nuclear will doubtless find uses for such developments as reliable graphite–graphite and graphite-metal brazing and high-speed circuit-data scanning and interpretation circuits which will automatically shut down a process if a preselected percentage of parameters lies outside set limits. Such a system prevents unnecessary shut-downs in continuous processes, and in the compact solid-state-device form developed at Winfrith suggests a number of useful applications in general industry.

This, then, is Winfrith in 1960: a rapidly expanding—yet already large—research establishment in which, directly and indirectly, a significant part of our industrial future is being shaped.

Exchanging ideas electronically

For two decades, engineers with a belief in electronics have dreamed of finding an all-electronic alternative to the electromechanical automatic telephone exchanges which have been known for half a century longer. Certainly, electrons rather than masses of metal would appear to be a more logical approach to the exchange of the commodity involved, namely information conveyed by minute quantities of electricity.

Existing types of exchanges are not, however, to be forced into obsolescence by a philosophical argument, but by solid facts of performance and cost. Electronic exchanges have been known for some years in laboratories, but only recently have there been signs of the dream becoming an economic reality. This country is to have an electronic exchange in public service in a year or two, and other countries have similar projects in hand.

An opportunity to discuss these developments and the subject generally is being provided by The Institution at a conference on electronic telephone exchanges to be held at Savoy Place on the 22nd–24th November 1960. The international response which has been received to the preliminary announcement indicates the interest in the subject all over the world.

It is interesting to reflect that electromechanical switches and techniques developed for automatic telephone exchanges were later found to be useful in computing systems. To give only two examples, the telephone companies have supplied totalizators in large numbers to the racing world, and early attempts to produce digital gunnery predictors used telephone-exchange switches.

The basic difference in the speed requirements of exchanges and computers caused the two arts to separate. New apparatus emerged—magnetic drums, acoustic delay lines, ferrite cores and others—and new techniques, to which the invention of the transistor has given a welcome fillip.

H.M. Postmaster General

Experimental electronic telephone exchange, Dollis Hill, London

Magnetic-drum equipment on which is recorded information relating to the subscribers' lines

The computer art also produced a new language, including words such as 'memory', 'store' and 'logic', which described apparatus by its function and not by its construction. Here is seen the influence of mathematicians, to whom computers owe much of their origin. Telephone exchanges were the product of engineers, who used to talk 'circuits' rather than functions. These same engineers, on learning the computer language, were surprised to find that memories, stores, logic, programmes and so forth were concepts which they understood all the time, but perhaps not quite so clearly, in telephone language.

It is not surprising that the two arts are again on common ground, but with the exchange engineer adopting ideas and apparatus from the computer engineer. Hence, although the main contributions are expected from telephone specialists, it is believed that the conference will have a wider interest.

Programme of the Institution conference on electronic telephone exchanges

THE Institution conference on electronic telephone exchanges, arranged by the Electronics and Communications Section, will be held at Savoy Place on the 22nd, 23rd and 24th November 1960. A preliminary list of the papers accepted for reading at the conference is given below, grouped according to session. An asterisk denotes that a preprint of the paper can be obtained in advance on application to the Secretary of The Institution. The sessions are from 10 to 12.30 a.m., 2.30 to 4.30 p.m., and 5.30 p.m. onwards on the 22nd and 23rd November. There will be an opportunity for groups of participants to visit the Post Office Research Station, Dollis Hill, London, to see a model electronic exchange on the 24th November.

10 a.m., 22nd November

Opening address by the Engineer-in-Chief of the General Post Office, A. H. Mumford, O.B.E., B.SC.(ENG.)

Session 1—Time-division-multiplex exchanges—I (10.45 a.m.)

***The Highgate Wood experimental electronic telephone exchange system: general introduction** (*3376*) by L. R. F. Harris, M.A., V. E. Mann and P. W. Ward, B.SC.(ENG.)

THE design of the experimental public-service telephone exchange to be installed at Highgate Wood, London, is examined.

***Outlines of a t.d.m. 2-wire telephone switching system and its control** (*3391*) by H. Adelaar, F. A. Clemens and J. Masure

BASIC principles of switching and logic system design are illustrated in an outline description of a fully solid-state switching system for large exchanges of the order of 10000 lines and 1000 junctions. Speech transmission is ensured on a single-wire time multiplex p.a.m. basis, using the principle of resonant transfer between modem circuits.

***A mobile tactical electronic telephone system** (*3385*) by J. G. Pearce

THE author describes a 4-wire lightweight automatic system intended for tactical use by the U.S. Field Army, and explains the choice of a t.d.m. technique using semiconductors.

Session 2—Time-division-multiplex exchanges—II (2.30 p.m.)

***Crosstalk in t.d.m./p.a.m. switching systems due to capacitive coupling in the highway-interconnecting network** (*3395*) by J. Broux

EXPRESSIONS for the inter-highway crosstalk are derived as functions of the parameters of the transmission path and the time-shift between the switching control pulses.

Session 3—Time-division-multiplex exchanges: Highgate Wood (5.30 p.m.)

***Reliability and maintenance of electronic telephone exchanges** (*3375*) by W. T. Duerdoth, B.SC.(ENG.), and J. A. Lawrence

***Highgate Wood electronic telephone exchange: facilities and problems of compatibility** (*3374*) by C. A. May, M.A.

THE problems involved in introducing a new type of exchange into an existing telephone network are discussed. The author describes some of the lesser-known facilities given by a modern automatic exchange, and explains how these will be provided at Highgate Wood.

***Principles of connection control in an electronic telephone exchange by the use of magnetic drums** (*3394*) by R. G. Knight, B.SC.(ENG.), V. E. Mann

FUNCTIONS of storage in a telephone exchange are considered, in particular the use of a magnetic drum in an electronically controlled t.d.m. exchange.

Line-scanning processes in a magnetic-drum-controlled electronic telephone exchange by R. G. Knight, B.SC.(ENG.), and R. D. Allum

THE authors study the problems of non-synchronous operation and widely differing time-scales between the magnetic drum and the speech multiplex, where the drum is used to control the testing of subscribers' lines and transmission of information between the drum store and other parts of the exchange.

Magnetic-drum storage and originating-call detection in an electronically controlled t.d.m. telephone exchange by D. G. Bryan, D.F.H., and J. S. Arnold

***Exchange code translation in a magnetic-drum-controlled electronic telephone exchange** by R. D. Allum, and D. G. Bryan, D.F.H.

***Terminating-call connections in a magnetic-drum-controlled electronic telephone exchange** (*3397*) by R. G. Knight, B.SC.(ENG.), and R. D. Allum

***Subscribers' meter recording in an electronic telephone exchange** (*3398*) by R. G. Knight, B.SC.(ENG.), and N. Hunter

***Register equipment for a time-division-multiplex electronic telephone exchange** (*3386*) by J. E. Flood, PH.D., and B. D. Simmons

THE operations performed by the register equipment for setting up various types of call are described, and continuity in fault conditions is explained.

***Supervisory equipment for a t.d.m. electronic telephone exchange** (*3383*) by A. D. Martin

THE operation of the common supervisory equipment used in the Highgate Wood electronic telephone exchange is examined in relation to a simple successful local call.

Session 4—Space-division systems—I (23rd November, 10 a.m.)

Space-division electronic telephone exchanges by F. H. Bray, A.C.G.I., and L. J. Murray, B.ENG.

TYPES of component proposed for use as crosspoints are discussed. A description is given of the trunking and control of a space-division switching system, consisting of line concentrators and a high-usage switching network, through which calls can be set up on a one-at-a-time basis.

***The Morris electronic telephone exchange** (*3382*) by W. Keister, R. W. Ketchledge and C. A. Lovell

THE experimental installation studied provides dial-telephone service in Morris, Illinois, U.S.A., for about 600 subscribers during the trial period.

Session 5—Space-division systems—II (2.30 p.m.)

***Experimental model of an electronic telephone exchange employing *p–n–p–n* transistors as crosspoint elements** (*3381*) by A. Heetman

THE *p–n–p–n* transistors are used as switching elements at the crosspoints of a space-division system, and the control of this

network for setting up a connection is explained. The control equipment is briefly described.

***The *p–n–p–n* diode as a crosspoint for electronic telephone exchanges** (*3377*) by J. E. Flood, PH.D., and W. B. Deller

THE authors discuss the way in which a speech connection through a single switching stage is set up using coincident voltage pulses.

Session 6—General (5.30 p.m.)

***Programme-controlled logical systems in electronic telephone exchanges** (*3390*) by H. H. Adelaar and A. Salle

IN the first part of the paper the necessary elements for such systems are considered, and in the second part a specific example is examined in detail.

***The capacitive semipermanent information store and its uses in telephone exchanges** (*3367*) by J. Van Goethem

THE new device described makes use of patterns of capacitive couplings at the crosspoints between rows and columns of a matrix arrangement, which patterns can easily be changed manually according to the information to be stored. Printed-wiring techniques are used throughout.

***Transmission network planning with electronic telephone exchanges** (*3373*) by T. H. Flowers, M.B.E., B.SC.

REDUCTIONS in mean loss which can be achieved by electronic exchanges are discussed. The choice between analogue speech transmission and the pulse-code-modulation system is studied.

CORRESPONDENCE

JUNCTION TRANSISTORS AND THEIR APPLICATIONS

AFTER reading Mr. J. A. Chandler's article 'Junction transistors and their applications' (August 1960 *Journal*, p. 494), I am more than ever convinced it is time physicists and engineers tidied up their nomenclature—and perhaps their thinking. Mr. E. Wolfendale, in his very interesting reply in the February 1959 *Journal* to my last letter on the subject, agreed that the terms 'negative' and 'positive' in connection with electrons and holes should be omitted in future but suggested that engineers should take on trust a new carrier of 'positive' electricity, the hole.

Do we then go back over 100 years to the days of the 'two-fluid' theory of two separate kinds of electricity, 'positive' and 'negative'; or can we still regard the term 'current' as meaning a flow of electrons and the terms 'negative' and 'positive' as being indicative of the direction of the flow to or from a particular point in a circuit such as a battery pole or a terminal of a generator? In electrostatics, must we unfortunately still go on calling an accumulation of electrons a negative charge and the condition produced by withdrawal of electrons a positive charge? It seems the terms ought to be reversed.

Mr. Wolfendale asks: does anyone know what an electron really is? I do, for one. Mr. Wolfendale does, too, because he says it is a representation. So is every other noun; a noun being, of course, the name given to a particular set of circumstances or properties. An electron is therefore that particular set or association or collection of characteristics or properties we have agreed to *call* an electron. I think the term 'carrier' ought to be dropped. The term 'negative carrier' seems to mean an electron and when in motion is simply a current—it cannot be regarded as carrying itself. The 'hole' meets the requirements much better than 'positive carrier'.

Coming to Mr. Chandler's article, he states that the diffusion of the carriers forms a potential barrier. What is a potential barrier? What does it bar—potential? Potential in its electrical sense is the ability to cause a current to flow when a path is provided for it. Does a potential barrier mean that the diffusion prevents a potential from being created? Or does it mean the reverse and that the diffusion creates a potential which has to be opposed by a higher one before a current will flow? If so, is it not just a high resistance or an insulator which, like others, breaks down at a certain voltage?

Later on he mentions the impedance of the input and output circuits. Does the impedance vary with the particular arrangement adopted, and does the efficacy of the various arrangements therefore depend on the frequency? If so, some indication of how this happens might with advantage be given; but if not, why refer to impedance at all instead of simply resistance?

He also says, '. . . a current gain of almost unity'. What does a current gain of 'unity' mean? If it means that the output current is equal to the input current, it is obviously not a gain. Or does it mean that the output current is the same as the input current but through a higher impedance (or resistance) and there is therefore a *power* gain? Subsequently he speaks of a current gain of 50. 50 what? 50dB? 50 times as much? Or perhaps 50%?

You see what I mean about tidying up. We are very grateful to the various authors who explain the new developments; but, although many of us are only engineers and as such are recommended to take on trust what the physicists tell us, we have nevertheless a certain rugged intelligence, and we would understand them a lot better if they used the accepted names for familiar things, and were a little more precise in their explanations. Not that I think their new jargon is in the same category as that of some: the civil engineers, for instance, who call bridges and tunnels fly-overs and underpasses; the commercial people who call a large self-service shop a supermarket; and our own nuclear-power-station brothers who call boilers heat-exchangers.

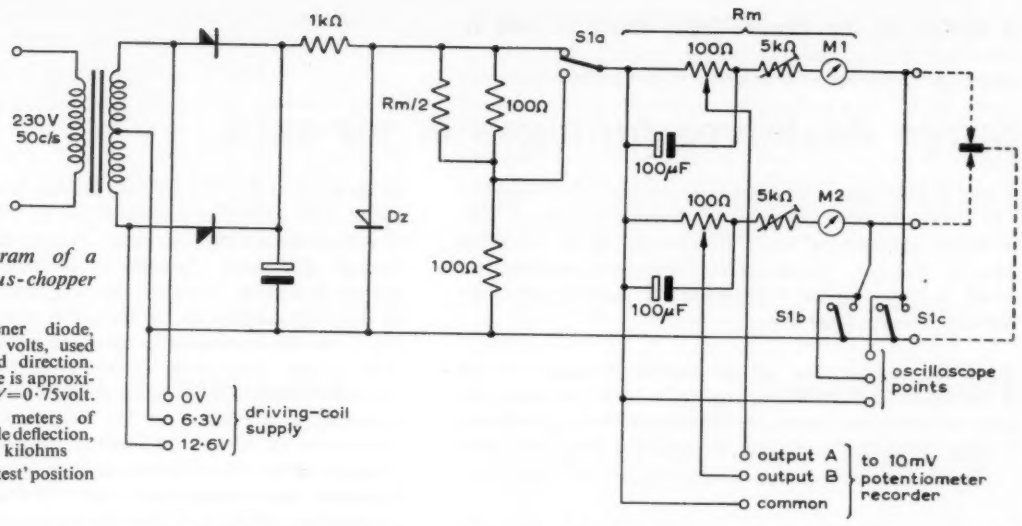
O. D. ROBINSON, MEMBER
90 West Cliff Road
Bournemouth, Hampshire

20th September 1960

SYNCHRONOUS-CHOPPER TEST SET

THE following circuit (Fig. 1) may interest members who are responsible for the maintenance and setting up of synchronous convertors as used in many types of graphic recorder and d.c. amplifier.

The basic circuit (Fig. 2) operates as follows: With the switch S1 closed, the meter reading is adjusted to maximum



1 *Circuit diagram of a synchronous-chopper test set*

Dz is a Zener diode, nominally 6·8 volts, used in the forward direction. Slope resistance is approximately 2ohms. $V = 0 \cdot 75$volt.

Rm/2, using meters of 120 μA full-scale deflection, should be 1·55 kilohms

S1 is shown in 'test' position

(100%). With the switch open and chopper operating, the meter will indicate the dwell time of the contacts being tested.

Since, in our application, it was not required to indicate a dwell time greater than 60%, and in order to provide a more accurate reading, particularly when the contacts are to be adjusted, the full-scale range of the instrument was limited to indicate a maximum dwell time of 60%. The adjustment mechanism usually causes interaction between settings of the contacts, so a double-pointer moving-coil meter was used. This gives a simultaneous reading for both contacts.

Calibration of the instrument is effected by means of a single switch which short-circuits the chopper contacts and halves the applied voltage. Preset resistors are then adjusted to set each meter reading to 50%.

The d.c. supply is stabilized at 0·75 volt by a Zener diode used in the forward direction. The moving-coil instrument used had a full-scale deflection of 120 μA. This ensures that contact ratings of the choppers can never be exceeded.

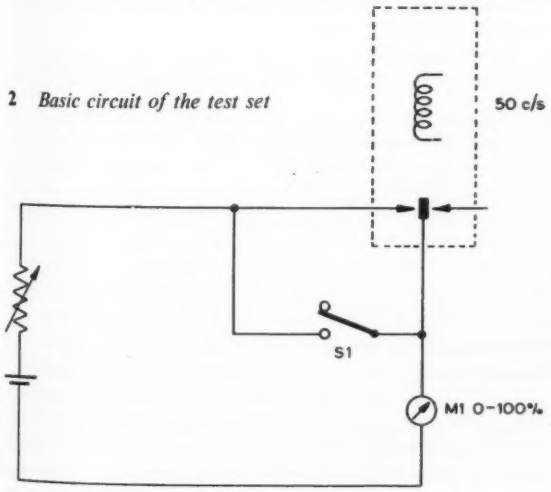
The driving-coil supplies of 6·3 and 12·6 volts are obtained from the windings which supply the direct current. The supplies are wired direct to the chopper sockets. For the chopper with top connections, flying leads with plugs are supplied. These can be plugged into 6·3 or 12·6 volts, as required (Fig. 3).

The 100ohm potentiometers in the meter circuits are used as take-off points to supply potentiometer recorders where long-term variations in dwell time are being studied. The smoothing requirements of these outputs are very simple.

The oscilloscope points are of value for checking convertors for contact bounce etc.

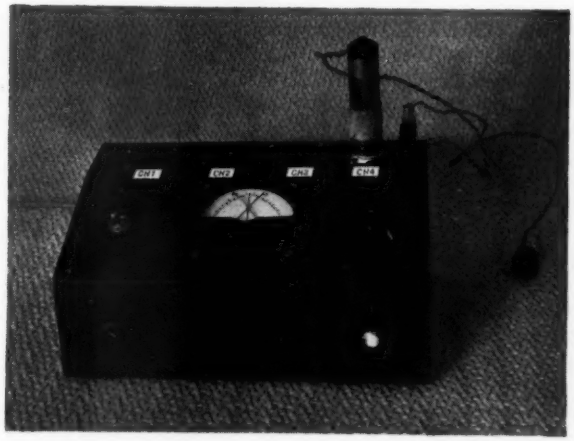
J. MARTIN, GRADUATE
Instrumentation Laboratories
Distillers Company Ltd.
Research and Development Department
Great Burgh
Epsom, Surrey

14th August 1960



2 *Basic circuit of the test set*

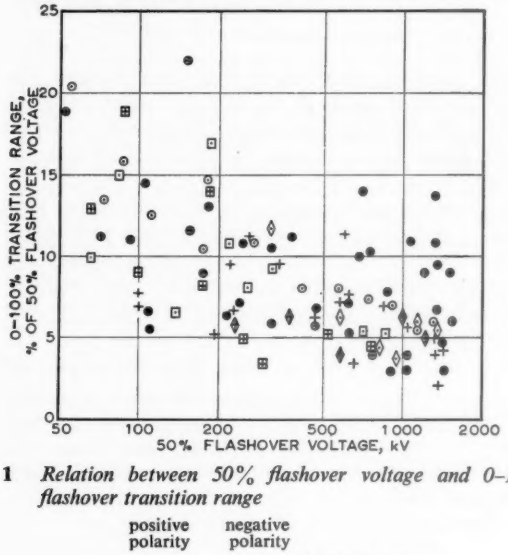
3 *A complete instrument for the testing of four different types of synchronous chopper*



Surge flashover voltages of air-gaps

A brief article based on a Supply Section paper (3317) entitled 'The surge flashover voltages of air-gaps associated with insulators and bushings' by G. W. Bowdler, M.Sc., Associate Member, and R. C. Hughes, B.Sc. The paper is published this month in Part A of the Proceedings. The authors are at the National Physical Laboratory.*

For the co-ordination of the electric strengths of the insulators and protective gaps used on an overhead-line power-transmission system, knowledge of the magnitude of a surge voltage of specified waveshape which will cause flashover of these components in 50% of the applications of the surge is an important requirement. The paper includes a summary of the results obtained in the determination of the 50% flashover values and in further tests at higher voltages on a wide range of types and sizes of insulator and air-gap used on overhead lines. The voltage waveshape in the absence of flashover was 1/50microsec.



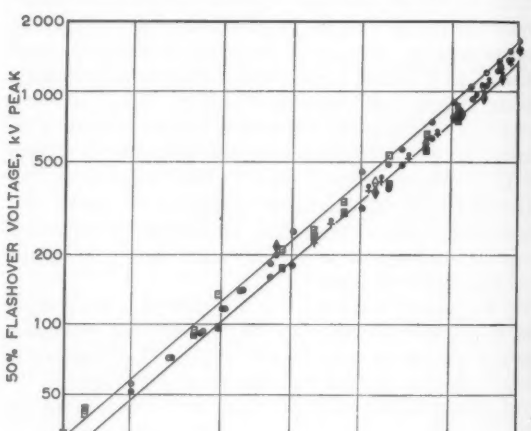
1 *Relation between 50% flashover voltage and 0–100% flashover transition range*

positive polarity	negative polarity	
+	●	insulator strings
●	⊙	rod-gaps
⊞	⊡	bushings
♦	◊	posts

50% flashover voltage

The 50% flashover voltage was derived from an exploration of the range of voltages over which there was a transition from no flashover to flashover on every application of the surge; the surges were applied at a number (ranging from five to ten) of voltage levels within this range. From a straight line drawn through the points obtained by plotting applied voltage against percentage flashover, the 50% flashover voltage and an arbitrary measure of the transition range were obtained. Fig. 1, which summarizes the results of many such determinations, shows fairly wide variations in the extent of the transition range but a general tendency for the range, expressed as a fraction of the 50% flashover voltage, to decrease as the size of the insulator or gap increases.

Values of the 50% flashover voltage obtained on different occasions on a given insulator may vary from their mean by as much as ±10%, even after the results have been adjusted in accordance with Appendix A of B.S. 137 : 1941 to allow for variations in atmospheric density and humidity. Much of this variation can be attributed on statistical grounds to the limited number of surges employed in each determination.



2 *Relation between 50% flashover voltage (1/50microsec wave) and length of flashover path*

positive polarity	negative polarity	
+	●	insulator strings
●	⊙	rod-gaps
⊞	⊡	bushings
♦	◊	posts

Fig. 2 shows the relation between mean 50% flashover voltage V and length of flashover path L for most of the arrangements tested. Nearly all the experimental points lie between the two parallel lines, which have been drawn to

* This article is based on, and written by the authors of, a current Institution paper. The authors have been asked to make this article, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the topic, and the content of the article is not necessarily confined to the subject-matter of the original paper

represent the upper and lower limits of the relation between V and L given (where L is in inches) by the equation:

$$V = 30L^{0.85} \text{ kilovolts} \pm 10\%$$

This relationship appears to apply to a point-to-point-like electrode system for which the flashover voltage is independent of polarity. The few results which lie outside the limits relate to systems having an appreciable polarity effect, and even here the average value for the two polarities is within the limits.

Tests at higher voltages

At the 50% flashover level, breakdown of a gap occurs with some delay, which increases with the length of the gap and amounts to 10–15microsec for long gaps. As the voltage is increased, the time to flashover and also any difference between the positive and negative flashover values decrease. A voltage of approximately 1·5 times the average of the positive and negative 50% flashover values is necessary to cause breakdown in 2microsec.

621.315.624 : 621.317.333.8

Theory of surges in transformer windings

A synopsis of a Supply Section paper (3287) entitled 'Oscillations in a transformer winding with particular reference to the response to an applied surge' by B. L. Coleman, B.Sc., Associate Member. The paper is published this month in Part A of the Proceedings. The author is in the Ministry of Defence, Government of Israel.

EXISTING single-limb theory is revised by differentiating between magnetizing and leakage inductance effects. Analysis of m.m.f. and flux in multi-limb transformers permits extension of the theory to a winding on two or three limbs. Solution of these cases is obtained by resolution into equivalent single-limb windings. Transient response to surges is discussed, and expressions are derived for current and potential distributions.

621.314.2.045

Experiments on surges in transformer windings

A synopsis of a Supply Section paper (3286) entitled 'An experimental study of surges and oscillations in windings of core-type transformers' by E. L. White, B.Sc.(Eng.), Associate Member. The paper is published this month in Part A of the Proceedings. The author is with the Electrical Research Association.

MEASUREMENTS on two experimental core-type transformers, one with two limbs and the other with three limbs, were used to test the validity of theories of transient oscillations in windings, with particular reference to Coleman's theoretical treatment of multi-limb transformers. Wherever practicable, 'equivalent single-limb' parameters were measured in accordance with this theory. Spectral distributions of oscillation frequencies and variations of mutual leakage inductance between winding elements with separation between elements were adopted as the main criteria in comparisons of experiment and theory.

These comparisons showed the superiority of an exponential distribution of mutual inductance over other approximations assumed in theories. No critical oscillation frequency, as predicted by Rüdenberg, was reached or approached, but some support was found for assuming the velocity of travelling waves to be independent of frequency when calculating inter-section voltages.

Measured responses in terms of spatial distribution, amplitude and waveform showed reasonable agreement with theory. The analytical treatment by Coleman of the transient behaviour of multi-limb transformers was verified by numerous tests.

621.314.2.045.15 : 621.3.015.3

Humidity and breakdown voltage

A synopsis of a Measurement and Control Section paper (3322) entitled 'Influence of humidity on the breakdown voltage of 2, 6·25, 12·5 and 25cm sphere-gaps and uniform field gaps' by E. Kuffel, M.Sc., Ph.D., A.Inst.P. The paper will be published in Part A of the Proceedings. The author was formerly in the Research Department, Associated Electrical Industries (Manchester) Ltd., and is now at Manchester College of Science and Technology.

STUDIES were made of the influence of humidity on the breakdown voltage of gaps in air. The voltages were measured for gaps between uniform-field electrodes and between spheres. The sphere-gaps comprised 2, 6·25, 12·5 and 25cm-diameter spheres, which were enclosed in an air-tight chamber in which the humidity was varied between 0 and 17mm Hg of water-vapour pressure. An increase in breakdown voltage of up to 5·5% was observed for some gaps when the humidity was increased.

The change in voltage for a given change of humidity varied with gap length and with the shape of the electrodes. It was largest for uniform-field electrodes and decreased with decreasing size of sphere. With sphere-gaps, the effect increased with gap length, reached a maximum at a spacing which depended on the sphere diameter, and then decreased to about half the maximum as the gap was increased still

Synopses of papers

THE following are synopses of papers published in the *Proceedings* which have not been read at Institution meetings and which have not been reviewed in the *Journal*. They are included here primarily for reference. Reprints will be available about two months after publication

further. The results were obtained with sphere-gaps which were varied up to maximum lengths approximately equal to the sphere diameters. 621.315.618.2 : 621.317.333.6

Self-oscillating induction motor

A synopsis of a Utilization Section paper (3273) entitled 'Further developments of the self-oscillating induction motor' by E. R. Laithwaite, M.Sc., Ph.D., Associate Member, and G. F. Nix, M.Sc., Student. The paper is published this month in Part A of the Proceedings. The authors are in the Electrical Engineering Laboratories, University of Manchester.

THE self-oscillating induction motor described in an earlier paper, in which two linear motors placed back-to-back are capable of producing a stable amplitude of oscillation of a moving runner without any switching device, cannot be made to operate in small sizes without careful design. Among the possible applications of such a system, a traverse mechanism for textile package winders appears to be the most attractive. One of the principal requirements of traverse mechanisms is that the oscillating member should be as small as possible.

The authors describe the development of small self-oscillating motors of several types. In some of these the rotors or runners contain iron, while in others they consist of slabs of conducting material. The system is found to operate in transient conditions at all times, and it has not been possible to establish a complete theoretical analysis. Nevertheless, an experimental approach has indicated some of the rules by which a small oscillating motor may be designed. Rotors of the order of only 30g mass have been made to oscillate successfully, and speeds of over 500 traverses/min over a 14in. length have been achieved with power input of the order of 100 watts. 621.313.333.4

Image method for machine end-winding fields

A synopsis of a Utilization Section paper (3327) entitled 'The application of the method of images to machine end-winding fields' by C. J. Carpenter, M.Sc.(Eng.), Associate Member. The paper is published this month in Part A of the Proceedings. The author is in the Department of Electrical Engineering, Imperial College of Science and Technology, University of London.

ALTHOUGH a variety of methods have been used to calculate the fields associated with the end-windings in rotating electrical machines, there appears to have been little attempt to exploit the method of images. This provides a means of solving the field problem by integration with relatively high accuracy. By making use of the vector potential, a comparatively simple calculation is possible of the flux linkages due to complex end-winding arrays. The author extends the image principle to circuits which are partly embedded in the reflecting surface. The effects of various complexities in the boundary conditions, including the presence of the air-gap, are considered.

The method is well suited to both turbo-type alternators, with magnetic and non-magnetic end-rings, and to induction motors. It is illustrated by calculating the end-winding inductance of a 2-layer induction-motor winding.

621.313.1.013.24

Microwave spectroscopy

A synopsis of an Electronics and Communications Section paper (3331) with the above title by D. J. Millen, B.Sc., Ph.D. The paper will be published in Part B of the Proceedings. Dr. Millen is Reader in Chemistry, Sir William Ramsay and Ralph Forster Laboratories, University College London.

THE author indicates the scope of microwave spectroscopy and its relationship to other branches of spectroscopy, special attention being directed to those aspects which are important in the design of spectrometers. The factors determining spectrometer sensitivity are discussed. The basis of molecular modulation is presented with special reference to Stark modulation.

The various types of spectrometer are reviewed and their relative merits discussed. The author considers the application of the method to chemical analysis and indicates the directions in which further experimental work is required.

621.317.794.029.6 : 621.375.9 : 539.19

Aspects of microwave radiation

A synopsis of an Electronics and Communications Section paper (3315) entitled 'Industrial, biological and medical aspects of microwave radiation' by A. F. Harvey, D.Phil., B.Sc.(Eng.), Member. The paper will be published in Part B of the Proceedings. The author is at the Royal Radar Establishment.

THE author reviews the industrial, biological and medical aspects of microwave radiation, the special methods of study of the properties of organic and biological materials being discussed first. The industrial applications of microwave heating processes are described, and the effect of microwave radiation on biological tissues and living animals is examined. The author points out the operational hazards attaching to personnel in the neighbourhood of high-power equipment and suggests how these can be minimized. The survey concludes with a bibliography.

621.371.029.6 : 614.898 : 621.365.92

Permittivity measurement

A synopsis of an Electronics and Communications Section paper (3316) entitled 'A new cavity-resonator method for measuring permittivities' by J. K. Sinha, M.Sc., Ph.D., Graduate, and J. Brown, D.Sc.(Eng.), Associate Member. The paper will be published in Part B of the Proceedings. The authors are at University College London.

THE authors discuss the difficulties of the usual cavity-resonator methods, and give details of a new method which eliminates most of these at the expense of increasing the computation required to interpret the results. The theory of the new method is described in full, and typical examples of experimental results obtained by its use are given. 621.317.335

PAPERS AND MONOGRAPHS

published individually this month

PAPERS

The training of oversea graduate engineers with particular reference to the F.B.I. scholarships scheme *Paper* 3358, *Part A*

W. ABBOTT, C.M.G., O.B.E., PH.D.

THE author deals with problems arising from the training, in the engineering industry of Great Britain, of graduates from countries oversea, primarily from underdeveloped countries. The paper relates mainly to the scholarships scheme operated by the Federation of British Industries, a scheme which, though relatively small, deals with carefully selected men from a large number of countries.

The author examines the philosophy of postgraduate practical training in the United Kingdom, and assesses the extent of this training in industry. He suggests that the total annual intake of graduates, from both home and oversea, is of the order of 5500, and discusses the possibility of increasing this number.

He then considers the influence of the requirements of the major professional engineering institutions on schemes for the practical training of graduates. He discusses the possible inappropriateness of British training methods for many of the visiting engineers, and suggests improvements.

The author concludes by considering the impact of greatly increased demands which will be made on Great Britain and other countries of the West by the emerging nations in the Commonwealth and by other developing countries.

Appendixes give the balance-of-trade position with countries covered by the F.B.I. and Athlone Fellowship schemes, and a letter from the late Sir Claude Gibb relating to the training of Canadian graduates.

To be read on the 3rd November 1960

Discrete analogue-computer compensation of sampled-data control systems *Paper* 3341M, *Part B*

T. GLUCHAROFF, M.E.

THE author describes an analogue computer which can solve pulse transfer functions and operate as a discrete controller for compensation of sampled-data or continuous systems. Operational amplifiers and silicon-diode switches are combined to perform the basic functions of sampling, holding and time-delay.

The accuracy obtainable is comparable with that of digital controllers, but the analogue computer has the advantages of simplicity of setting-up and low cost. Adjustment of the controller parameters is easy, and the computer can be used to determine the coefficients of the pulse transfer function for optimum operation before a digital computer is employed. A simplified method of discrete-controller design for saturating sampled-data systems is also presented.

To be read on the 15th November 1960

The design of an audio-frequency amplifier for high-precision voltage measurement *Paper* 3335M, *Part B*

S. HARKNESS *and* F. J. WILKINS, B.A., B.SC.

THE specification and design of an amplifier required for precision audio-frequency measurements are discussed. The authors present formulae for the 'ring of three' feedback circuit and make a detailed analysis of appropriate feedback theorems.

Papers accepted for reading at meetings, and monographs, are first published individually and are republished later in the Proceedings of The Institution; as soon as the separates are available, they are described in this feature. The papers are supplied free of charge; the price of a monograph is 2s.

In addition, reprints of papers read at meetings, including the discussions thereon, and of papers not read at meetings, become available, price 2s., within two months of their appearance in the Proceedings.

Applications quoting the serial number of the paper, monograph or reprint as well as the author's name, and accompanied by a remittance where appropriate, should be addressed to the Secretary of The Institution. For convenience, books of five vouchers for this purpose can be obtained in advance, price 10s.

Those who obtain a copy of a paper published individually are urged—if they do not take the Part of the Proceedings in which it will be republished—to apply in due course for a reprint, as this is the final and correct version and includes the discussion.

A multigain amplifier which extends the voltage range of the electrostatic voltmeters used at the N.P.L. as basic a.c./d.c. transfer instruments is described. An increase in this range of up to 1000 times is provided and enables voltages between 60mV and 60 volts in the frequency range 30c/s–30kc/s to be measured to a few parts in 10^4.

To be read on the 10th January 1961

MONOGRAPHS

Unstable electron flow in a diode *Monograph* 402E

R. J. LOMAX, M.A., PH.D.

THE author uses a perturbation analysis to demonstrate the instability of a type of electron flow in a plane diode known as C-overlap flow, which is predicted to be a possible flow in the approximation in which electrons are emitted from the cathode with a uniform velocity.

A new approach to Kron's method of analysing large systems *Monograph* 403E

R. ONODERA

GENERALLY, an electrical network is used as a model circuit for a physical field, but this circuit is complicated and its analysis is frequently difficult. 'Diakoptics', introduced by Kron, is very effective for analysis of the network. The method entails the operation of 'cutting', which is generally classified into open-circuiting and short-circuiting. The latter operation is the dual of the former but, as far as the author is aware, has not yet been reported in any of the literature.

He describes a method, based on Kron's diakoptics, which uses the operation of open-circuiting and is further extended to dual diakoptics treated by the operation of short-circuiting. Here a simplification of Kron's diakoptics is attempted and a dual method is introduced. It seems that this attempt goes backwards in tensor geometry, but forward in combinatorial topology. The author's chief intention is to show the duality between diakoptics and codiakoptics.

Papers and monographs published individually this month (continued)

Pole-face losses in alternators: an investigation of eddy-current losses in laminated pole shoes *Monograph* 404S

PROF. J. GREIG, M.SC.(ENG.), PH.D., *and* K. SATHIRAKUL, B.SC.(ENG.), PH.D.

A RECENT re-examination of the phenomenon of tooth-ripple flux pulsations at laminated pole-faces in alternators resulted in a new theoretical analysis by means of which the pole-face eddy-current loss can be calculated. The primary purpose of the present investigation has been to make measurements of tooth-ripple losses which could be compared with values calculated from the new formulae.

In order to make these measurements, an experimental homopolar machine was built, and eddy-current losses were determined over a fairly wide range of flux density and frequency for four different thicknesses of lamination.

It is found that there is moderately good agreement between calculation and experiment for the thicker laminations, and in general the agreement is markedly better with the new formulae than with those previously developed.

Audio communication with orthogonal time functions *Monograph* 405E

H. F. HARMUTH, DIPL.-ING., DR.TECH.

AN audio signal may be decomposed into components having certain frequency and phase. Half the information of the signal is contained in the phase of the frequency components. Since the human ear is almost insensitive to phase, one may eliminate the phase information without causing a noticeable reduction in the signal quality. The elimination of the phase information implies a permissible reduction of the bandwidth required for the transmission of the signal to one-half and a reduction of the signal power by 3dB without increase of distortions due to additive white normal noise.

A method for the elimination of the phase information is based on the decomposition of the audio signal by correlation with a set of orthogonal functions. These correlations yield for each orthogonal function one coefficient which is represented by a voltage. One may process these coefficients in analogue or digital computers to reduce further the bandwidth required for the transmission of audio signals with certain spectral distribution, e.g. voice signals.

The physical realization of induction-motor equivalent circuits *Monograph* 406U

N. N. HANCOCK, B.SC.(ENG.), M.SC.TECH., *and* B. H. KARAKARADDI, B.SC., M.SC.TECH.

THE authors review the practicability of setting up physically, in the form of specialized networks, several of the equivalent circuits representing an unbalanced 2-phase induction motor. This motor is sufficiently general to include, as special cases, most induction machines with balanced secondary windings.

Optimum combination of pulse shape and filter to produce a signal peak upon a noise background *Monograph* 407E

H. S. HEAPS, B.SC., M.A.

THE author studies the generation of a signal pulse for transmission through a propagating medium and its subsequent detection as a single peak after it is received on a noise background. It is supposed that the propagating medium behaves as a linear filter and that the noise background is independent of the signal. The pulse is conveniently described as consisting of a central portion attached to a leading edge and a trailing edge.

It is found that, for a given length of central portion, there is an optimum combination of transmitted pulse shape and predetection filter. Comparing the results with those arising from the use of certain non-optimum systems, the author finds that the optimum system leads to a significantly high signal/noise ratio.

The author's results imply that, for the range of parameters considered, it is advantageous to transmit a succession of short pulses of a determined form rather than a single smooth pulse.

The potential distribution and thermionic current between parallel plane emitters *Monograph* 408E

F. H. REYNOLDS, B.SC.(ENG.)

THE author analyses a thermionic system formed of two parallel plane emitters facing each other. By means of tables, the distribution of potential between the emitters, and the net space-charge-limited current which flows between them, can be obtained for any values of emitter potential, temperature and saturation current density. The results are applied to practical problems, including the thermoelectric and conductivity characteristics of oxide cathodes.

Propagation along unbounded and bounded dielectric rods. Part 1—Propagation along an unbounded dielectric rod *Monograph* 409E

P. J. B. CLARRICOATS, B.SC.(ENG.), PH.D.

THE author describes a method for evaluating the propagation coefficients of an unbounded lossless dielectric rod of infinite extent. The propagation coefficients are obtained as a function of the ratio of rod radius to free-space wavelength, r_1/λ_0, for the three lowest modes of propagation possessing fields with θ dependence of the form $\varepsilon^{\pm j\theta}$. The method of solution enables the form of the complete mode spectrum to be identified.

It is also established that the product of the rod permeability and permittivity, $\mu\epsilon$, primarily determines the propagation behaviour; the ratio μ/ϵ has only a secondary effect. An expression is obtained for the distribution of transmitted power between the rod and the surrounding space, and it is also demonstrated that the product $\mu\epsilon$ primarily determines this quantity. Correlation between power distribution and attenuation is demonstrated for a rod possessing small losses.

Propagation along unbounded and bounded dielectric rods. Part 2—Propagation along a dielectric rod contained in a circular waveguide *Monograph* 410E

P. J. B. CLARRICOATS, B.SC.(ENG.), PH.D.

THE author explains both approximate and exact methods for evaluating the phase-change coefficients of a circular waveguide containing an axial dielectric rod. Close correlation is found between the phase-change coefficients of this waveguide structure and those of an unbounded rod over a wide range of rod radii. The correlation enables an unambiguous classification of the modes of an unbounded rod to be made.

Exact and perturbation expressions are derived for total transmitted power, power distribution and attenuation in the dielectric-rod-waveguide structure. Correlation with the attenuation coefficients of an unbounded rod is again predicted. The application of the results to ferrite devices is briefly mentioned.

The launching of surface waves by a magnetic line source *Monograph* 411E

C. M. ANGULO *and* W. S. C. CHANG

THE authors deal with the idealized problem of the excitation of surface waves along two infinite, identical, separate and parallel dielectric slabs by a magnetic line source (slot). The problem is reduced to a superposition of simpler ones, namely two parallel slabs with symmetrical excitation and two parallel slabs with antisymmetrical excitation.

The simplified problems are solved by the modal-analysis approach, and the synthesis of the modal components is carried out to obtain the far fields excited by the magnetic line.

Radiation pattern, total power of the surface waves, total radiation loss and the efficiency of launching the surface wave are derived and computed numerically for various thicknesses of the slabs, various air-gaps between the slabs, and different positions of the magnetic line source. The theoretical results indicate that, for each thickness of the slabs, high efficiency is obtained with an

optimum location of the source and an optimum air-gap. Moreover, the thicker the slabs, the higher is the maximum efficiency. The thickness of the slabs and the air-gap are ultimately limited by the requirement that only one surface wave should exist for the structure.

The output spectral density of a detector operating on an f.m. c.w. radar signal in the presence of band-limited white noise
Monograph 412E

J. LAIT, M.A., *and* A. J. HYMANS, M.SC.

A METHOD of analysis suggested by Lawson and Uhlenbeck is used to examine the interaction between reference signal, echo and noise in the detector stage of a frequency-modulated c.w. radar receiver.

The authors give a method of approximation which may be used in most practical cases and state the restrictions on system parameters for which the approximations are valid.

Expressions for spectral density are derived separately for both quadratic and linear detectors, and the question of optimum pre-detector bandwidth is examined. Finally, the authors consider how signal/noise ratio will be affected by choice of bandwidth in stages which follow the detector.

OBITUARY

WILLIAM CROSS

William Cross who died on the 20th June 1960 was born at Gringley on the Hill, Nottinghamshire, on the 19th December 1873. He was educated at Woodhouse Grove School, Bradford, and commenced his career in the electrical industry with Crompton and Co., Chelmsford, in 1890 as an apprentice and later joined their London office as a junior engineer.

In 1897 he joined O. L. Falconar to form Falconar, Cross and Co., Newcastle upon Tyne, with whom he was associated until his death.

He was a founder-member of the Electrical Contractors' Association, being president from 1915 to 1917. He was chairman of the Newcastle Centre of the Illuminating Engineering Society from 1945 to 1947.

Among his many activities he will be remembered in the North as a Freemason, a musician, a churchman, and a talented organist. He was organist at the Methodist Church in Chelmsford, Essex, at the age of 17 and later deputy organist of Jemond Methodist Church, Newcastle, and a trustee for 33 years. He was master of the Faraday Lodge of Freemasons in 1937–38 and was a past provincial grand deacon in 1945. He was a member of Newcastle Rotary Club from 1916 to 1933.

He is survived by his widow and two daughters.

He joined The Institution as an Associate in 1897 and was elected an Associate Member in 1899 and a Member in 1917. He served as chairman of the North-Eastern Centre in 1919–20 and on the Ship and Wiring Rules Committee in 1916–17. J. G.

WILLIAM CHARLES GOMERSALL

William Charles Gomersall who was born on the 26th January 1895 died on the 4th July 1960. He was educated at St. Stephen's School, Paddington, and received his electrical engineering training at Regent Street Polytechnic, London, and part-time at Manchester College of Technology while apprenticed to Lancashire Dynamo and Motor Co., Trafford Park.

In 1919 he went to China and was in charge of the power and electrical department of the Jardine Engineering Corporation, and his success in his new field was striking. In 1928 he formed China Engineers Ltd., a British concern in Shanghai.

He had the rare facility of making personal and business friendships with Chinese industrialists, and contributed largely to the development of the cotton and woollen industries in the Yangtze valley and North China, being able just before the Pacific War started to assist in providing substantial amounts of capital for these purposes.

He was interned with his family in Shanghai and rebuilt China Engineers after liberation. He was one of the last British industrialists to leave Shanghai after the Communist take-over, being (wrongly) convinced that there must be a continuing demand for the services he could render to industry there. In Hong Kong he continued his work; and China Engineers, by its faith in textile prospects, made a great financial, and Gomersall a great personal, contribution to Hong Kong's prosperity.

His activities in latter years spread to other parts of the Far East, to London and to Canada. He was a devoted Christian Scientist.

He joined The Institution as a Student in 1915 and was elected an Associate Member in 1922 and a Member in 1940. He served on the China Local Centre Committee in 1937–38 and was vice-chairman from 1938 to 1940 and from 1946 to 1948, and chairman from 1941 to 1943. G. E. M.

THOMAS LEOPOLD HORN

Thomas Leopold Horn who was born at Greenwich on the 10th March 1870 died on the 12th May 1960. He studied electrical engineering at Nottingham University for three years and in 1888 became a foreman with B. Verity and Son.

In 1889 he joined Siemens Brothers, Woolwich, and was engaged in laying and testing cables in England, at sea—he sailed in the old *Faraday*—and in South America up the Amazon River. In 1895 he was in charge of the laying of h.v. power cables across Shoreham Harbour and in 1903 laid the first h.v. cable network for London County Council tramways from Deptford power station and later connected them to the newly-built Greenwich power station.

When the Council started on the conversion of the North London section of their tramways, he was offered and accepted the position of distribution engineer to the area, where he remained until the union with the London Passenger Transport Board in 1933. He retired in 1934.

He was a keen Freemason and was extremely musical, being an efficient pianist and organist. He was a man of strong character, not afraid of work, to which he gave practically his whole strength. In his later years he was a diabetic and had to ease up somewhat, but his strength of character was such that he adhered strictly to a diet and refused to subject himself to insulin. He is survived by two sons and a daughter.

He joined The Institution as a Student in 1888 and was elected an Associate in 1891 and a Member in 1905. He served as honorary secretary of the Student Section in 1889. F. H. W.

ROBERT NELSON

Robert Nelson, WH.EX., who died on the 16th June 1960 was born on the 22nd October 1874. He was educated at Liverpool Institute and received his technical training at Liverpool School of Science and at Liverpool University while serving a four-year apprenticeship with Cochrane and Co., Birkenhead.

While at the university, he formed a lifelong friendship with the late William McLellan. After experience with Cork Electric Tramway and Lighting Co., Ireland, and Walker and Wallsend Union Gas Co., Wallsend on Tyne, he joined Merz and McLellan in 1903 as one of their first engineers, in which capacity he took a leading part in the design of the Carville generating station at Wallsend, a station which has been recognized as heralding the beginning of the modern trend of power-station design.

In 1908 he became the first electrical inspector of mines, Mines Department, Home Office, under Sir Richard Redmayne and was largely responsible for the formulation of safety regulations dealing with the use of electricity in coal mines. During the 1914–18 War, he was attached to the coal control department. He subsequently rejoined his old firm and in 1927 became a partner with McLellan in McLellan and Partners, which took over the industrial consulting work of Merz and McLellan.

On his retirement in 1939, he continued his interest in electrical affairs and acted as arbitrator in a number of cases. He was a director of the Galloway Water Power Co., and on the death of

Obituary (continued)

Lord Meston succeeded him as chairman, which position he held until the company was nationalized in 1948.

Nelson was a man who impressed all who met him by his charm of manner combined with great fairness and real wisdom. He was always willing to give a helping hand to younger men, and many of the present generation of electrical engineers owe much to his kindly guidance and advice during their formative years.

He joined The Institution as a Member in 1919. He was awarded a Whitworth Exhibition in 1897, and his papers 'Electricity in mines: a short survey' and 'Electricity in coal mines: a retrospect and a forecast' [a Paris Exhibition (1881) premium being awarded for the latter] were published in the *Journal* in 1926 and 1939 respectively.

H. H.

SYDNEY GEORGE REDMAN

Major Sydney George Redman, O.B.E., who died in Johannesburg on the 4th June 1960, was born in London in 1875. He obtained his engineering training with Brush Electrical Engineering, studying part-time at London Polytechnic School of Engineering and passing the City and Guilds examination. Subsequently he joined the Dublin United Tramway Co. and after a period on the power system was put in charge of the construction and maintenance of the tramways electrical equipment. Later, by arrangement with the company, he independently laid out and superintended the construction of the electrical equipment of the Isle of Thanet and the Dublin and Howth tramways systems.

After two years as superintending engineer for Dick, Kerr, in charge of work at Grimsby, Tyneside, Carlisle and Sunderland, he joined Merz and McLellan in 1902 as traction engineer and spent the remainder of his career with them. He was largely engaged on tramway work, and also prepared plans and estimates for the Belfast Corporation Tramways Parliamentary Bill and dealt with inspection and testing of equipment for Adelaide tramways, Australia. He was also responsible for the design of the early overhead transmission lines on the North-East Coast.

However, his principal work was the electrification of railways, beginning with some 80 miles of track on the Tynemouth branch of the North-Eastern Railway, the first section of which was put into operation in 1904 and was the first example of a railway in Great Britain converted from steam to electric traction. He then accompanied Charles Merz to Melbourne, visiting Canada and the United States on the way, in connection with the Melbourne suburban system of the Victoria Railway. He was also concerned with schemes in Buenos Aires, Bombay and South Africa.

During the 1914–18 War he became adjutant of the 2nd/5th Northumberland Fusiliers and later deputy assistant director of railways and roads, Royal Engineers. He was appointed an Officer of the Order of the British Empire.

After the war, the traction department of Merz and McLellan was transferred from Newcastle to London, where he remained until 1937. Then, at the age of 62, he undertook the responsibility of going to South Africa as the resident partner of the new associated firm, Merz and McLellan (South Africa), where he remained until he retired in 1952, after which he continued with the firm as a consultant until his death.

His services were of great value during the difficult period of the Second World War, when communications were bad and the firm was engaged in the extension of many of the power stations in the Union to meet the demands of the rapidly growing war industries. He became a very widely known and popular figure in electric-power supply circles in South Africa and was elected an honorary member of the Association of Municipal Electrical Undertakings in Southern Africa.

Before he went to the Union, he was a member of the Savage Club, and one of his chief enjoyments was their house dinners. He was a member of the Rand Club and Country Club in Johannesburg. 'The Major', as he was always called, was of a very kindly and sociable disposition and even to the last was keen on dancing. He is survived by four married daughters, one being the well known actress Joyce Redman.

He joined The Institution as a Member in 1911 and served as a member of the Transvaal Local Committee from 1945 to 1950.

J. R. B.

TECHNICAL PUBLICATIONS

FURTHER information and copies of the publications can be obtained from the organizations concerned, except where otherwise stated

BOARD OF TRADE

Soviet patent and trade mark law. H.M.S.O., London, 1960. 2s. 6d., postage 4d.

THIS is the final report of the three-man British delegation which visited Moscow in December 1959 to investigate the protection available in the U.S.S.R. for foreign, especially British, inventions. Translations are included of relevant Soviet laws, including the recent one of April 1959.

BRITISH TRANSPORT COMMISSION

British transport in 1959. British Transport Commission, London, 1960. 2s.*

THIS is an illustrated report of the year's progress in the activities of the British Transport Commission. In appendixes, the net receipts of the various services and passenger and freight traffic for 1959 are compared with those for 1958.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Research for industry 1959. H.M.S.O., London, 1960. 8s.

THE work of each research association is described briefly. In addition, there is a special illustrated article on 'Instrumentation and automatic control in industry' by Dr. J. Thomson, Director of the British Scientific Instrument Research Association.

* Available from the Publicity Officer, British Transport Commission, 222 Marylebone Road, London N.W.1

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH: BUILDING RESEARCH STATION

Factory building studies no. 6. **Noise in factories** by A. G. Aldersey-Williams. H.M.S.O., London, 1960. 3s. 6d., postage 4d.

NOISE in factories produces annoyance, interference with communication, and eventually hearing damage. Noise level is largely determined by the type of process but is also indicative of inefficient machines. Excessive noise outside the factory can result in legal action from local residents. The first part of this booklet deals with the effects of noise, and the second part with methods of reducing noise, including specific remedies by individual manufacturers.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH: NATIONAL PHYSICAL LABORATORY

The refractive index of air for radio waves and microwaves. D.S.I.R., London, 1960. n.p.*

THE booklet contains tables of the refractive index of air for a wide range of temperatures, pressures and water-vapour pressures, based on formulae derived by Drs. L. Essen and K. D. Froome.

HOKKAIDO UNIVERSITY

Monograph series of the Research Institute of Applied Electricity no. 8 (1960). **Some developments in network theory.** Hokkaido University, Sapporo, Japan, 1960. n.p.

OF chief interest in this issue are specific problems of passive reactance networks to be used in radar and telecommunication systems. Five papers are included: 'Pulse-forming networks',

* Obtainable from the National Physical Laboratory, Teddington, Middlesex, England

'Filters with small phase distortions', 'Studies on transmission line filters', 'Constant impedance termination of coil-loaded cables', and 'Impedance equalization of transmission lines at low frequencies'.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Publication 72–2. **Recommendations for the dimensions and output ratings of electric motors.** Part 2—Dimensions of mounting flanges for electric motors. Geneva, 1960. 6 Sw. fr.*

THE recommendations apply only to flange-mounted induction motors with outside diameter of flange 90–1000mm (9¼–22in.). Two series of standard dimensions are recommended, one for flanges in metric dimensions and the other for flanges measured in inches.

NATIONAL COAL BOARD

Production Department Information Bulletin 60/218. **Visual signalling systems for underground locomotives.** National Coal Board, London, 1960. n.p.

AFTER a discussion of the purposes and means of signalling, the bulletin gives a comparison of commercially available systems and equipment.

ORGANISATION FOR EUROPEAN ECONOMIC CO-OPERATION: EUROPEAN NUCLEAR ENERGY AGENCY

O.E.E.C. high temperature reactor project Dragon. First annual report 1959–1960. O.E.E.C., Paris, 1960. 5s.†

THE first section surveys briefly the historical background and structure of the Dragon project, while the two remaining sections describe in technical detail the first year's progress in research and development, and reactor design and construction.

PERGAMON PRESS

Silicon carbide. A high temperature semiconductor. Pergamon Press, London, 1960. £4 10s.

THIS contains the full proceedings of the international conference on silicon carbide in April 1959 at Boston, Massachusetts, U.S.A. Possible uses of the material as a rectifier, transistor, electroluminescent source, thermoelectric generator, etc. are evaluated. Details of crystal growth are included.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Sixth annual report 1959–60. H.M.S.O., London, 1960. 5s.

THE official report contains chapters on finance, production plants, the reactor development programme, controlled thermonuclear reactions, health and safety, international relations, etc. The contents are summarized in a general survey in chapter 1.

Atom 1960. H.M.S.O., London, 1960. 2s. 6d.

THIS is an illustrated summary of the sixth annual report from the 1st April 1959 to 31st March 1960, plus extra material to the 1st July 1960.

Different types of reactor and their fuels are described and applications of radioisotopes discussed. Other subjects include training, health and safety, international relations and events of the year.

* Obtainable from the I.E.C. Central Office, 1 rue de Varembé, Geneva, Switzerland

† Obtainable from the Public Relations Branch, United Kingdom Atomic Energy Authority, 11 Charles II Street, London S.W.1

WORLD POWER CONFERENCE

Annual report 1959. Central Office of the World Power Conference, 1960. n.p.

THE booklet contains information on publication of the transactions of the Sectional Meetings held since 1957, relations with intergovernmental organizations, and the financial affairs of the Conference. It also includes the report of the International Commission on Large Dams.

British Nuclear Energy Conference

DETAILS of five forthcoming meetings of the British Nuclear Energy Conference are given below. Papers and discussions on the applications of nuclear energy and ancillary subjects are published in the quarterly *Journal of the British Nuclear Energy Conference*. The annual subscription payable by members of The Institution who wish to receive the *Journal of the B.N.E.C.* regularly is 30s. post-free. Single copies are available at 7s. 6d. each

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OCTOBER 25 *Tuesday* (5.30 p.m.)

Sponsoring society: The Joint Panel on Nuclear Marine Propulsion
Place of meeting: The Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London E.C.3

SOME OBSERVATIONS ON THE DESIGN AND CONSTRUCTION OF THE N.S. *SAVANNAH* J. A. Dodd and S. Macdonald

NOVEMBER 8 *Tuesday* (5.30 p.m.)

Sponsoring society and place of meeting: The Institution of Civil Engineers, 1–7 Great George Street, London S.W.1

SOME CONTRIBUTIONS FROM NUCLEAR POWER TO ENGINEERING PRACTICE I. Davidson

NOVEMBER 9–10 *Wednesday* (2.30 p.m.)–*Thursday*

Sponsoring society and place of meeting: The Institution of Mechanical Engineers, 1 Birdcage Walk, London S.W.1

SYMPOSIUM ON THE USE OF SECONDARY SURFACES FOR HEAT TRANSFER WITH CLEAN GASES

Information on the papers to be presented at the symposium is published in the October 1960 issue of the *Journal of the B.N.E.C.* Further details and registration forms may be obtained from the Secretary of The Institution of Mechanical Engineers

NOVEMBER 30–DECEMBER 2 *Wednesday* (9.30 a.m.)–*Friday*

Sponsoring society: The Iron and Steel Institute
Place of meeting: Church House, London S.W.1

SYMPOSIUM ON STEELS FOR REACTOR PRESSURE CIRCUITS

Some 20 papers, giving the results of recent research in Canada, Great Britain and the United States, will be presented and discussed during the meeting's five sessions. These will cover high-temperature properties; corrosion; fabrication aspects; irradiation effects; and steels for future reactors.

Further details may be obtained from the Secretary of The Iron and Steel Institute, 4 Grosvenor Gardens, London S.W.1

DECEMBER 7 *Wednesday* (2.30 p.m.)

Sponsoring society: The British Nuclear Energy Conference
Place of meeting: The Institution of Mechanical Engineers, 1 Birdcage Walk, London S.W.1

SYMPOSIUM ON THE DOUNREAY FAST REACTOR

Information on the papers to be presented at the symposium is published in the October 1960 issue of the *Journal of the B.N.E.C.* Further details may be obtained from the Secretary of The Institution of Mechanical Engineers

LIBRARY ACCESSIONS

**Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members*

BOOKS

ATKINSON, W. G. 539

Introduction to atomic energy

New York: Rider. London: Chapman and Hall, 1959. pp. vii, 68. 22 × 15cm. 12s.

A short, simple explanation of the basic principles, written for the non-technical reader.

BRANS, P. H. 621.385

Television and special tubes vade-mecum. 15th edition

Antwerp: P. H. Brans, 1959. pp. xii, 320. 29 × 20cm. 38s.

The 14th edition (1958) dealt with radio valves; this edition covers cathode-ray tubes, controlled rectifiers, special v.h.f. tubes, gas-discharge tubes, phototubes, radiation counters and various miscellaneous devices.

CANNON, C. G. (*Editor*) 621.38

Electronics for spectroscopists

London: Hilger and Watts, 1960. pp. 333. 22·5 × 14cm. £3

Considers mainly the salient features of amplifiers of different kinds, negative feedback, noise and power supplies, but includes some information on semiconductors, photoelectric devices and cathode-ray tubes. This book was reviewed in the August 1960 *Journal*, p. 501.

COTTON, H. 621.31

Applied electricity. 5th edition

London: Cleaver-Hume Press, 1960. pp. xii, 516. 22·5 × 14cm. 25s.

Based primarily on Part I of the London B.Sc.(Eng.) degree examination, it covers adequately the most recent requirements of a group of examinations, including Part I of the Institution Examination and those for the National Certificates. The fundamentals of electricity and magnetism are included so that the volume shall completely satisfy a student's needs. Contains many worked examples and also examples to be worked by the student. This edition has been extended by a long section on non-linear resistors and semiconductors and an expansion of the chapter on electronics.

DAWES, C. L. 621.31

Industrial electricity. Vol. 2—Alternating currents. 3rd edition

New York and London: McGraw-Hill, 1960. pp. xvi, 573. 23·5 × 15·5cm. £2 18s.

A new edition of an elementary work for electrical engineering students which deals with the theory and applications of alternating currents.

DELAVENAY, E. 413: 681

An introduction to machine translation*

London: Thames and Hudson, 1960. pp. ix, 144. 22 × 14·5cm. 25s.

Describes the historical background leading to the present stage of development and the problems yet to be resolved.

KING, R. W. P., and WU, T. T. 621.396.11

The scattering and diffraction of waves*

London: Oxford University Press, 1959. pp. xvii, 218. 22 × 14cm. 32s. 6d.

Deals with theory and experiment applied to electromagnetic scattering and diffraction from the surface of complex shapes. It is based on work at Harvard University. This book will be reviewed in a future issue.

HUGHES, E. 621.3

Electrical technology*

London: Longmans, 1960. pp. xiv, 694. 19 × 12·5cm. 18s.

For the second- and third-year courses for the Ordinary National Certificate in electrical engineering. The M.K.S. system is used throughout, but a conversion table is provided. It contains over 100 worked examples and 670 problems for the student to solve.

KIVER, M. S. 621.396.619

F-M simplified. 3rd edition*

Princeton: Van Nostrand, 1960. pp. vi, 376. 23·5 × 15·5cm. £2 5s.

In the first part of this book, the principles of frequency-modulation transmission and reception are explained and compared with amplitude-modulation techniques. The second part is devoted to the design, operation and servicing of f.m. equipment. This edition includes a bibliography and a list of faults and their possible causes.

KOVACS, K. P. 413 = 00

Villamos gépek [Electrical machines—vocabulary in Hungarian, German, English and Russian]

Budapest: Terra Budapest, 1959. pp. 164. 20 × 14cm. 20s.

413 = 00

Altalanos elektrotechnika [General electrical engineering—vocabulary in Hungarian, German, English and Russian]

Budapest: Terra Budapest, 1958. pp. 236. 20 × 14cm. 30s.

LEWIS, I. A. D., and WELLS, F. H. 621.396.615

Millimicrosecond pulse techniques. 2nd edition*

London and New York: Pergamon Press, 1959. pp. xviii, 417. 22 × 14cm. £2 10s.

Discusses the theory and design of electronic circuits and devices for operation in the range of time-intervals which lies between 10^{-6} and 10^{-10} sec. Systems of large bandwidth are the primary concern—on the one hand, conventional pulse circuits embodying lumped circuit-elements are pushed to the limit of speed, and, on the other, arrangements are developed in which the parameters are deliberately distributed in space and which possess wave-propagation properties. It contains a considerable amount of new material, including information on transistor-type devices capable of high switching speeds.

LIBBY, C. C. 621.34

Motor selection and application*

New York and London: McGraw-Hill, 1960. pp. xi, 508. 24 × 16cm. £5 4s. 6d.

This is a concise presentation of data for selecting a motor for a particular purpose. It examines the characteristics and mechanical and electrical details of a.c. and d.c. machines. This book was reviewed in the September 1960 *Journal*, p. 552.

MILLER, H. A. 621.315.3

First year electrical installation practice*

London: Edward Arnold, 1960. pp. viii, 152. 18·5 × 12cm. 6s. 6d.

Consists of explanatory notes and a scheme of exercises intended to be used in conjunction with The Institution's Wiring Regulations.

MILLER, W. E. 621.397

Television explained. 7th edition

London: Iliffe, 1960. pp. xv, 192. 22 × 14cm. 12s. 6d.

A simple, practical book which deals with television receiving circuits and aerials, and the installation and operation of receivers. This latest

edition takes account of the modifications in design brought about by the availability of an alternative programme. There is an additional chapter in this edition on combined television and f.m. receivers.

MIDDLETON, H. A. 621.385

Master receiving-picture tube substitution guide book. 2nd edition

New York: Rider. London: Chapman and Hall, 1959. pp. viii, 343. 28 × 21·5cm. £3

The material of the original (1950) edition and its supplements is now consolidated. Additional material relates to cathode-ray tubes appearing since 1957, including some due to be introduced in 1960.

MIKOLAJCZYK, P. 621.385

Universal vade-mecum; electronic tubes and semiconductor elements

Warsaw: Państwowe Wydawnictwa Techniczne, 1960. pp. 1213. 29·5 × 20·5cm. £7

Comprehensive and international in scope, and notable for giving graphical characteristics and physical dimensions as well as the usual tabulated data and socket diagrams. The index distinguishes between old, current and novel types.

ROSSBERG, E., and KORTA, H. E. 621.394.3

Teleprinter switching*

New York and London: Van Nostrand, 1960. pp. 351. 24 × 16cm. £3 10s.

Originally published in German and now translated, it is intended as a systematic and comprehensive survey of teleprinter-switching systems in service in different parts of the world. Fundamentals are not dwelt on; instead, space is used to discuss the peculiarities and salient features of the various systems. This book was reviewed in the September 1960 *Journal*, p. 554.

STANFORD, E. G., and FEARON, J. H. (*Editors*) 620.17

Progress in non-destructive testing—Vol. 2*

London: Heywood, 1960. pp. vii, 250. 25 × 15·5cm. £2 15s.

This second annual volume of critical reviews includes papers on applications of electrical methods to the detection of flaws in and the study of metal structures, the use of ultrasonic waves, and paramagnetic resonance. This book will be reviewed in a future issue.

WELSBY, V. G. 621.318.4

The theory and design of inductance coils. 2nd edition*

London: Macdonald, 1960. pp. xviii, 232. 22 × 14cm. 30s.

In place of empirical methods of design, the author introduces refined calculations appropriate to components of precise characteristics, such as those used in telecommunication equipment. Laminated- and dust-core coils are treated; air-cored coils are considered fully. It includes a new chapter on coils with ferrite cores, and the rationalized M.K.S. system has been adopted.

WINTER, W. 621.396.9

Radio-control for model builders

New York: Rider. London: Chapman and Hall, 1960. pp. viii, 220. 21·5 × 14cm. $4.25

A simple, practical book on the subject.

OTHER PUBLICATIONS

BLAQUIÈRE, A.

Mécanique non-linéaire des oscillateurs à régimes quasi-sinusoidaux. Mémorial des Sciences Mathématiques, fasc. 141

Paris: Gauthier-Villars, 1960. pp. 137. 24 × 15·5cm. £2

BRITISH BROADCASTING CORPORATION

The power gain of multi-tiered v.h.f. transmitting aerials by P. Knight and G. D. Monteath. Engineering Monograph 31

London: B.B.C., 1960. pp. 38. 28 × 22cm. 5s.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE and THE ASSOCIATION OF BRITISH CHAMBERS OF COMMERCE

Decimal coinage and the metric system: should Britain change?

London: Butterworths Scientific Publications, 1960. pp. xi, 107. 24·5 × 15cm. 7s. 6d.

GENERAL ELECTRIC CO., SCHENECTADY, N.Y.

Structure and properties of thin films. Proceedings of an international conference held at Bolton Landing, New York, 9th–11th September 1959, edited by C. A. Neugebaur and others

New York and London: Wiley, 1959. pp. 561. 28 × 21·5cm. £6

INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS

Solid state physics in electronics and telecommunications. Vol. 4—Magnetic and optical properties—Part 2. Proceedings of an international conference held in Brussels, 2nd–7th June 1958, edited by M. Désirant and J. L. Michiels

London and New York: Academic Press, 1960. pp. xvi, 559–963. 25 × 15·5cm. £5

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

The elementary practice of electrical fishing in fresh water. Fisheries Notice 36

London: Ministry of Agriculture, Fisheries and Food, 1960. pp. 15. 21 × 13·5cm. n.p.

UNITED NATIONS

Proceedings of the second United Nations international conference on the peaceful uses of atomic energy, held in Geneva, 1st–13th September 1958. Vol. 33—Index of the Proceedings

Geneva: United Nations, 1958. pp. 201. 28 × 22cm. £5 18s.

District Meetings

ARRANGEMENTS for District Meetings in November 1960 other than in the area of a local Centre

November 1960

MAIDSTONE (at Maidstone Technical College at 6.30 for 7 p.m.)

7 *Monday* H. E. FRANCIS 'Subscriber trunk dialling'

OXFORD (at the Southern Electricity Board Service Centre, 37 George Street, at 7 p.m.)

9 *Wednesday* V. G. NEWMAN, B.SC.(ENG.) 'Pumped storage'

READING (at the George Hotel, King Street, at 7.15 p.m.)

21 *Monday* G. P. COPPING, B.SC. 'Electronics in postal mail services'

Television station at Ballachulish

THE B.B.C.'s proposal to build a low-power television station near Ballachulish, Argyllshire, has received the Postmaster General's approval in principle. The existing B.B.C. station at Rosemarkie will transmit programmes to the station at Kinlochleven (already approved) via the satellite station to be built at Fort William. Ballachulish will be used as a relay point to feed the programme to Kinlochleven, and will also give direct reception to some 1500 people in the immediate neighbourhood of Ballachulish.

Site and technical details of the Ballachulish station have not yet been authorized, but it will be built concurrently with the other satellite stations in Stage 1 of the B.B.C.'s scheme, these being scheduled for completion by March 1962.

THE INSTITUTION EXAMINATION

List of successful candidates

THE INSTITUTION EXAMINATION (PART I) APRIL 1960

BRITISH ISLES AND OVERSEA

The following have satisfied the examiners in the compulsory subjects of Part I (mathematics; applied mechanics; heat, light and sound; principles of electricity; and engineering drawing):

BULANKULAME, Tissa Sooriyakumara
CAREY, Patrick Lawrence
COHEN, Chaim
COLGAN, John Francis
CRAMMOND, Douglas Alexander George
DEVINE, Thomas Patrick
DHALLA, Mohamed Husein
DOYLE, Norman Patrick
FERNANDO, Thompson Mervyn
FOO, Cheng Theng
GRACIAS, Raymond Justinho
JAYAWEERA, Vernon Hemasiri Arumabadu
LIEW, Ter Kwang
LUNG, Chien Ping
McGIBNEY, Thomas Joseph
MAHER, Christopher
MURPHY, John Martin
MURRAY, John Brian
MUTHURAJAH, Nadarajah
O'DWYER, Brendan Joseph
O'SHEA, Alfred Fimbarr Joseph
PULENDRAN, Carthigesu Thiagarajah
RAHIM, Mohamed Aziz Sherali
SHARMA, Rajinder Kumar
SUHAIL, Ahmed Marzook Mohamed
WAIDYATILLEKE, Ananda Jayatilleke
WICKRAMASINGHE, Tissa Banda
WIKRAMANAYAKE, Nihal

The following candidates have satisfied the examiners in the subject of English:

ALI, Sadaqat
CONNERS, Derek
COORAY, Muthuthathrige Roland Edmund
DE SILVA, Bala Patabendige Senerath Lakdas
LOWE, Gordon Richard
NARAYANAN, Mandyam Ananda
PANG EE ANG
POPLE, Bertie Newton
SANDERSON, Kenneth
SENARATNE, Ananda
SINGH, Amrik
SRIPATHY, Kathrippillay
WATT, George

The following candidates have been permitted to enter the Examination under special conditions and have satisfied the examiners in the subjects shown:

BAILEY, Gordon[1]
DANIELS, Derek[1]
NICE, Richard Keith[1 2 3]
OWEN, Arthur Neville[1]

[1] *Heat, light and sound* [2] *Engineering drawing* [3] *Applied mechanics*

THE INSTITUTION EXAMINATION (PART II) APRIL 1960

BRITISH ISLES

ANDERSON, Albert Frederick William[1]
AULT, Maurice Peter[3]
BARNES, David William[1]
BASS, Ronald Paton[1 4]
BONNICK, Arthur Sidney[4]
BUTLER, Robert Gyabaa Jones[1]
CARROLL, Gerard Richard
CLAPSON, Philip[1]
COOPER, William John[2]
COSGROVE, Terence Anthony[1]
COWLEY, Christopher Vincent
CRADDUCK, Trevor David[1]
DALE, Anthony Peter[1]
DOWNES, John Thomas
EGAR, Kieran
ELKINS, Neil Albert
FEAR, David[1]
FISHER, Forest Francis Rutley[1]
FRASER, James[2]
HAKEEM, Mohammad Amanul[1]
HAMMOND, James William[3]
HARDING-JONES, Peter[1]
HEATH, Brian Thomas[4]
HOPSON, William Noel[3]
JACKMAN, David Radclyffe[1]
JORDAN, David Edmund[2]
KHERA, Ranjit (Roland)
LITTLE, Paul Anthony
LOMAS, Thomas
McCOLGAN, Anthony Eunan
MAGUIRE, Michael Gerard
MAHENDRAN, Paramoo
MAJUMDAR, Dipak
METTANANDA, Asoka
MISRA, Moni Mohan[3]
MURRAY, Hugh[1]
ORPEN, Vernon Ivan Norman Colin[1]
PARKER, Alan[2]
PARKER, Brian[2]
PEDERSEN, Aage
PETTIT, Patrick[1]
POLLARD, Colin[2]
PRINGLE, Anthony Edward[2]
REID, John Peter[2]
ROBERTS, John Stanley[2]
SMYTH, Patrick Noel
THORPE, Laurence Joseph John
WARDMAN, Derek[2]
WATSON, John Bethall[3 4]
WONG CHUN-WIN
WU YU-NGONG[1]

OVERSEA

ABAYAGUNAWARDHANA, Kariyawansa Ranaweerakankanamalage Don
AMARASINGHAM, Yogendiran[4]
COLACO, Claude Anthony
CORREA, Oswald Wilson
DANIEL, Michael
DAS, Jagdish Chander
D'SA, Edgar Benedict
FERNANDO, Warnaculasuriya Gregory Alfred
KARUNATILLEKE, Hemasiri Dias Silva
MITHA, Sadruddin Hasham
MURTY, Devarakonda Venkata Satyanarayana
NAIK, Anand Bhagwant
PANDIT, Chennagiri Madhukar
RADHAKRISHNANI, Girdharilal Balram
RAJADEVA, Subramaniam[3 4]
RAJANAYAGAM, Ilanganayagam
SANMUGARAJAH, Ambalavarnar[1 4]
TAMBIPILLAI, Samuel George Kuneratnam[1]
WIJAYATILLEKE, Don Gilbert Dharmasena

[1] *Electrical engineering I and II* [2] *Engineering physics* [3] *Thermodynamics* [4] *Mathematics*

THE INSTITUTION EXAMINATION (PART III) JUNE 1960

BRITISH ISLES

ABROOK, George Edward[5]
ADAMSON, Daniel Welsh[1]
ALLEN, Keith David[1]
ALLSOP, Gerald Anthony[4]
ANSDELL, Anthony Arthur[5 7]
APPLEBY, John Terence
ASHDOWN, Michael Bryan
ATKINS, Thomas Edward[3]
ATKINSON, William Charles[1]
AUSTIN, Kenneth Charles E.[1]
BAGGETT, John Edgar[1 3]
BALDWIN, Brian Edward[4]
BALDWIN, Richard Timothy[1 4]
BANFORD, Richard William[1 2]
BANKS, Peter John
BARFOOT, David William[1]
BARKER, Cyril Glyn
BARKER, Norman Stuart[1]
BARLOW, Michael Neil[2]
BARNES, Donald
BARNETT, Christopher Frank[5]
BATTEN, John Anthony[1]
BEARNE, Keith Paul
BEATUS, Claude[1]
BEAUMONT, Jack[1 2]
BECKINGHAM, Brian Francis[5 7]
BEDSON, Leslie Stuart[4]
BEESTON, Brian[1 5]
BENNETT, Roger Stephen
BENNIE, William Lyon
BENTHIN, Louis
BEST, Cyril Frank[5]
BLAIR, Peter Kenneth[1]
BLANCHARD, Colin Reginald[1]
BLAND, Dudley Moore[1]
BOND, Malcolm
BONNICK, Bryan John[5 7]
BOOTH, Roy Sims[1]
BOWEN, Kenneth Edward[4]
BOWRING, Stewart David
BOWSKILL, David John[5 7]
BOYLE, Stephen[1]
BRACE, John Lawrence
BRADSHAW, Frank[1]
BRAUDE, Bernard[1]
BRENNAN, Francis Michael[5]
BRENNAND, Terence[1 3]
BROADHURST, Derek[1]
BROOKE, Colin[1]
BROOKS, Lyn Alan[1]
BROOM, Colin Edward
BROWN, Brian Kenneth[1]
BROWN, Colin[1]
BROWN, Frank Walter Edward[1]
BROWN, John Nicholas[1]
BROWN, Raymond John[1 4]
BURN, Ronald Leon[1]
BURT, Clifford Richard Gordon[1]
BURTON, Godfrey Raymond
BURTON, Henry[1 4]
CALLENDAR, Michael Hugh[1]
CARTER, Robert Alan[1]
CASSERLEY, David John[5 7]
CASTLE, Anthony George[5]
CATON, Dennis James
CAVANAGH, Eric Joseph[7]
CHALLENDER, Victor Frederick[3]
CHALLIS, Michael Jeremy[8]
CHANDLER, Kenneth[7]
CHARLETT, Paul Francis
CHARLTON, Ian John Austin[1]
CHEETHAM, Philip Gordon[1]
CHINASING, Stephen Moyin[1]
CLARK, Brian James
CLARK, John Charles[5 8]
CLARKSON, Thomas Herbert[1 4]
CLAYTON, Harold Anthony[1]
CLEWS, Dudley Ernest[1 5]
COLDWELL, John Keith[1]
CONNELLY, Ralph[1]
CONNOLLY, James Alexander[1]
COOMBS, Brian Munro[1]
COOPER, Alan Cadmore[4]
COPLEY, Alan[1]
CORKING, James Michael[5]
COULBECK, Bryan[1]
COWLEY, Alan[5]
COX, Bernard Ronald
CRADDUCK, Trevor David
CRAGGS, Peter Arnold
CRAWFORD, Dennis Frank[1]
CROWE, Leslie
CROWTHER, Neil Graham
CRUICKSHANK, James McNicol[1]
CURTIS, Brian William[5 7]
CURTIS, Thomas Anthony
CUSCHIERI, Albert Edgar[1]
CUTHBERT, Allan Gordon[1]
DAGLESS, John Leslie[1]
DALE, Anthony Peter[1]
DAVID, Vivian
DAVIS, John Richard Cameron[1]
DAVIS, Keith Christian[1]
DAY, Gary Mervyn

DEAKIN, Barry[4]
DENTON, Anthony Jon[1]
DENVIR, John Michael[1]
DOSHI, Jayantilal Sakalchand[1]
DRYER, Sydney
DUDLEY, Leonard William[1]
DUTTA GUPTA, Ranjit Ranjan
DUXBURY, Frederick Grunwell[1]
DWYER, Alfred[4 6]
EAST, George Frederick[5 7]
EASLICK, John William[1]
ECONOMIDES, Dionysius Gregory[4]
EDWARDS, Ronald James[1]
ELLIOTT, Robert Lennox
ELLIS, Richard John Godwin[1]
EVANS, Kenneth Stuart
EVANS, Ronald Herbert James Pugh[3]
FAIRBROTHER, Leslie Ronald
FEATHERSTONE, David Hooton
FELLOWS, Kenneth Gordon
FORD, George[4]
FOWLER, Donald Geoffrey[1]
FRASER, James[1]
FREMONT, David de Mouilpied[1]
FROW, Roger[5 7]
FRYER, Michael[1]
FYFE, Robert Lendrum[5]
GABRIELS, Kenneth[2]
GARDNER, Frederick James[1]
GARDNER, Michael George[5 7]
GARRETT, John Arthur[1 5]
GAY, Michael John[1]
GEDGE, John Lewis[1]
GEERE, Ronald Durston
GEORGE, Emyr[5]
GEORGE, Royston Arthur[5 8]
GERRARD, George Alan
GHEST, Robert Clive[1]
GIBBON, Robert Roger[1]
GIBBS, Roy Charles[1]
GIBSON, Harry[1]
GIBSON, Michael[1]
GLEAVES, Casson Dawson[1]
GNANASABESAN, Subramaniam
GODIER, Roy Frederick[1 8]
GOLDSMITH, Michael John[1]
GORDON, Cormac Noel
GOSLING, David Samuel
GOTH, Diana Raby[6]
GOWARIKER, Shankar Ranchhod [1 5]
GRAHAM, Gerald Vincent[1]
GREEN, David Alwyn[1 4]
GREENWOOD, David[1 5]
GUNDLACH, Alan Michael[1]
HAINES, Gordon Edward[1 5]
HAKEEM, Mohammad Amanul
HALL, Edgar Ronald[1 7]
HALL, John Henry[1 5]
HALL, William[1]
HALLIWELL, David Anthony[4 6]
HAMMOND, James William[1]
HAND, Geoffrey
HANDFORD, Michael Phillip[5]
HANNAFORD, David Arthur[1]
HANNINGTON, George Edward John[4]
HARMER, Daniel Sidney[1]
HARRIS, John Cecil
HARRIS, Meurig[1]
HARRISON, Peter
HART, Anthony William[1 5]
HASLAM, Harry Myles [2]
HAWKINS, Arthur Terence[1]
HEATH, John Edward William
HELLIWELL, Alan James[7]
HEMELGE, Don Paschal Joseph[1]
HICKLING, Brian George[4]
HICKS, Gordon Graham[5]
HILL, Bryan James[2]
HILL, Colin Nicholson[4]
HILL, David George[1]
HILLIER, William Edward[1 5]
HINES, John Richard[1]
HINKLEY, Albert Arthur[1]
HINKS, Peter
HODGKINSON, Raymond Thomas[5 7]
HODGSON, Brian William[1]
HODGSON, Keith[4]
HOLLAND, Brian Alfred[5 7]
HOLLAND, Ian Malcolm
HOLT, Ian Roscoe[1]
HOMBURGER, Ernest Raphael[1]
HORSFIELD, Michael[8]
HOWICK, Ronald Edward[1]
HUGHES, William Glynne[1]
IRVING, Philip Byron[4]
JACKMAN, David Radclyffe[1]
JACKSON, Brian[1]
JACKSON, David Arfor[5 7]
JACKSON, David Gibson[1]
JACOBS, Murray Herbert[1]
JOHNSON, Colin Peter[1 4]
JOHNSON, Philip Ian[1]
JOLLEY, William Peter[1 4]
JONES, Gareth Edward[1]
JONES, Trevor Vaughan[1]
JONES, Wyndham[1 4]
JORDAN, David Edmund[1 3]
JORDAN, James Redmon[5 7]
KEATINGE, Peter Anthony Terence[1]
KENT, Allen Dewhurst
KIDDLE, Peter[1 5]
KILMINSTER, Robin Franklin[1]
KIRK, David William[2]
KNIGHT, James
KNOTEK, Stenek[5]
KRAJEWSKI, Mark
LAVENDER, Anthony William[2]
LAVENDER, William Anthony[1]
LEE, Brian Trevor[1]
LEE, David Alan[1]
LE-MARIE, John Richard[1]
LEWIS, John Rainsford
LOVERIDGE, John Edwin George
McCALL, Maurice[1 4]
McTIGHE, Anthony Norman
MANTON, Colin Brian[5 7]
MARRIOTT, Trevor[1]
MARSH, Leonard Maurice[5 7]
MARSHALL, Edward Trevor[1]
MARTIN, Raymond Geoffrey[5 7]
MARWICK, David Baikie
MASON, James Douglas[1]
MAYBURY, Francis Patrick[2 3]
MEECH, John Norman[1]
MEHRTENS, David Henry[1]
MEIMERY, Seif Salim Seif[1]
METCALF, John Hugh[3]
MIAO, Chi
MIDDLEMISS, John Johnston
MILLWARD, John David[5]
MILTON, Robert Leonard[8]
MINTO, Douglas Andrew[1]
MIRES, Arthur John[1]
MOAT, Alistair Cooper[1]
MONTEIRO, Alfred Peter[5 8]
MOONEY, Roy Marshall[2 4]
MOORE, Christopher John[1]
MOORE, John[1 4]
MORGAN, Brinley[2]
MORGAN, Thomas Geoffrey[1]
MORLEY, Alec Glynn[1]
MORRIS, Clive[1]
MORRIS, John Henry[5]
MOSES, George Edward[1]
MOSS, William Joseph Francis[1]
MUIR, Neil David
MUKHERJEE, Phanindra Nath
NEWTON, Robert Dorrick[1]
NIELSON, Adrian William[1 4]
NOBES, Michael James[1]
NORTON, Michael Alfred
NUTT, Peter Charles[1]
ODUNSI, Olatunda Isola[1]
OLDROYD, David Brian[1 4]
O'ROURKE, Peter John[1]
OSEMAN, Robert Henry[1 3]
OULTON, Timothy Norman[1 4]
OWENS, Thomas Victor[1]
PALMER, Brian William[1]
PARAMESVARAN, Thamotharampillai Vaithilingam[2]
PARKER, Alan
PARKER, Bernard Sydney
PARKER, John William[1 6]
PARKIN, Roger Edward[1]
PEABODY, Christopher John[1]
PENDLEBURY, Joseph[1 2]
PENERY, Michael Thomas[1]
PHILPOTT, Ronald George[1]
PICKARD, Robert Malcolm[4]
PICKERING, Laurence William[4]
PIGOTT, Peter Malcolm[1 5]
PILKINGTON, Donald James[1]
PILLAY, Ratnam Kandaswamy[1 2]
PITMAN, Richard John Griffith[1]
POFFLEY, David Arthur[1]
POLKINGHORNE, Michael John
POLLARD, Colin[1]
PONTING, Philip James
POOLEY, Christopher[5 7]
POWLEY, John Robert[1 4]
PRICE, Nicholas Nadine Aitken[5]
PRIESTLEY, George[1]
PROBERT, Peter Ernest[1]
RASHID, Abdul[2]
RAVEN, Barton[1]
REID, Bernard Edsell[1 4]
REID, John Peter
RICHARDSON, Colin Albert Stanley[3 8]
RILEY, John Netherwood
ROBERTS, Ieuan Lloyd
ROBERTS, John Stanley
ROBERTSON, Alexander[1]
ROBERTSON, John Alastair[2 8]
RODGERS, David Alexander[5]
ROGERS, Keith David
ROGERSON, Ralph Cecil
ROOKS, Leslie David[1]
ROSS, Robert Ian[1]
RYDER, David John[1]
RYE, John
SAMARAKKODY, Upali[1 6]
SANDERSON, John David[1]
SANDRASEGARAM, Sampanther
SAUNDERS, Trevor James[1]
SCHOLFIELD, Derek MacGarvey[1 5]
SCOTT, Claude Fredrick[1]
SCOTT, David Iain
SCOTT, Roy[1]
SCRUTTON, William Henry Charles[1]
SEALE, David Alexander[1]
SEDGWICK, Anthony
SHAH, Syed Jamal[1]
SHELDON, Neville Thomas
SHEWARD, Peter Thomas[1]
SHROPSHALL, Peter Edward[1 6]
SINCLAIR, Clive Robert[1]
SINGHA, Bindhyeshwari Prasad
SKIPPEN, David John Mason[1]
SMITH, Andrew Martin
SMITH, George William[1]
SMITH, Gordon Reginald
SMITH, John Arthur George[1]
SMITH, Laurence Sidney[1]
SMITH, Peter Henry[1]
SMYTH, Michael Charles[2 6]
SNOW, Anthony Cyril[1]
SNOW, Frederick Albert[1]
SPARKES, Peter Robert[1 3]
SPELLER, John Philip[1]
STAFFORD, Michael Robert[1]
STAGG, Kenneth Albert[4 6]
STANSFIELD, James Neil
STARLING, Donald Sidney[5 7]
STEELE, Brian Frederick[1]
STEPHENS, Robert John[1]
STERRY, John William[2 4]
SUMMERSCALES, Ernest[2]
TAMBE, Pratap Shripad
TAYLOR, Barry William[1 6]
TESSON, Adrian Richard[2]
THAYANANDARAJAH, Somasundram[1]
THOMAS, Stuart[1 3]
THOMPSON, Brian Henry[1 4]
THOMPSON, Ernest Kenneth[1]
THOMPSON, John Douglas[1]
THOMPSON, Terrence Edward[1]
THURBIN, Patrick John[5 7]
TILLEN, Peter John[2 6]
TIMMIS, Albert Gerald[7]
TINSLEY, David[2]
TITCHMARSH, Roy Saveil
TODD, Robert John[3 8]
TOMASINA, Ronald John Peter[4]
TOWERS, Alan[6]
TOWNSEND, David Brian[1]
TRITTON, Leslie Walter
TRUCKELL, Antony George
TRUMAN, Norman Nathan[1]
TURNER, Michael John Bainbridge[1]
TUSTIN, Allan Edward[1]
TWIST, Barry Hilton[5 7]
UNDERWOOD, John[1]
UNDERWOOD, Justin Dowsett[1 7]
VERNON, Nicholas Blake[1]
VINCENT, Dudley Joseph
VINNELS, John[1]
WADHAWAN, Virender[1 4]
WAINWRIGHT, Anthony
WAINWRIGHT, John Roy[1]
WALES, John[1]
WALKER, David John
WALKER, John Richard[1]
WARD, Kenneth
WARDLE, Terence Newton
WARDMAN, Derek[1]
WARNE, Anthony John[4]
WATKINS, Brian John[6]
WEBB, William John[1]
WEBB-CORNWALL, Harold[1 4]
WEBBER, John George[4]
WEST, William Anthony[4]
WESTERN, Anthony Albert Godfrey[1]
WHEATLEY, Barry
WHITAKER, Barry Stuart[1]
WHITE, Brian Francis Kenneth[1]
WHITE, Raymond Anthony[5]
WHITEHEAD, Bertram[1]
WHITEHOUSE, David John[1]
WHITEHOUSE, Joseph Colin[1]
WHITFIELD, Alexander Henry
WHITING, Barry Rex Anthony[1 5]
WHITING, John Percy
WICKS, Stuart Edward[5 7]
WILCOCK, John Slider
WILEBORE, Derek
WILKINS, Robert Peter William[1]
WILMAN, Hugh[7]
WILSON, Francis Cyril[1]
WILSON, John Grant[1 4]
WILSON, John Law
WOOD, David John[1]
WOOD, Ivor Thomas[1]
WOOD, William Malcolm[1 5]
WOOLGAR, Anthony John[1]
WOOLLEY, Peter Maxwell[1 4]
WORTH, Alan[4 6]
WRIGHT, William[3]
YARDLEY, Raymond Lloyd Luxton[1 6]
YATES, Albert[1 5]
YORK, John David[1]
YOUNG, Arthur[1 6]
ZAINUDDIN, Mohammad Jalaluddin[2]

OVERSEA

AMARASINGHAM, Yogendiran[1 4]
ANAND, Vidya Bhushan
ARUMUGAM, Kandiah[3 4]
BALASUBRAMANIAM, Thambippillai Vaithialingam[3 4]
BHATKAR, Chandrakant Pandurang[1]
GOONASEKERA, Lakshman Kirthisri[4]
GUNAWARDENA, Jaya Abeysingha
KAMALANATHAN, Sivagurunathar[1]
LEE, Wing Kee
MEHTA, Ramchandra Nathalal[4]
MOHIDEEN, Mohamed Junaid[7]
MURTY, Devarakanda Venkata Satyanarayana
PERERA, Marcus Vincent Romanis[4]
RAGAPATHY, Mylvaganam[3 4]
SANTHIAPILLAI, Arulanantham Gnanendrarasah[1]
SANTHIRAN, Ganapathipillai
VELSAMY, Appathurai[1]
VIVEGANANTHAN, Parampalam

[1] *Advanced electrical engineering* [2] *Electrical machines* [3] *Electrical measurements* [4] *Electricity supply* [5] *Electronic engineering* [6] *Utilization of electrical plant* [7] *Radiocommunication* [8] *Line communication*

Elections and transfers

The following elections and transfers approved by the Council of The Institution are effective from the 15th September 1960

ELECTIONS: 1st LIST

Graduates

BARLOW, Gordon Thomas
BRIGHT, Robert Edward, B.SC.(ENG.)
BROWN, Leonard
BURT, Clifford Richard Gordon
CAMP, Thomas Aitken, B.E.
CONNERS, Derek
DANIELS, Derek
ECONOMIDES, Odysseas Charalampous, B.SC.(ENG.)
FRENCH, John Frederick
GALLAGHER, Edward Joseph, B.E.
GARFORTH, David Lister, B.SC.
GHAI, Nirmal Kumar, B.SC.(ENG.), M.SC.TECH.
GOODALL, Charles
GRAVINA, Christopher Manfred, B.SC.(ENG.)
GREGORY, William Reginald, B.SC.(ENG.)
HARBOROW, Peter Robert Hyde, B.SC.
KELLY, John Peter, B.SC.
KERSHAW, Brian Leslie, B.SC.
KHALID, Bin Din
KRAFT, Eugene, B.SC.(ENG.)
LAMDEN, Ralph James, B.SC., M.SC.
LASHFORD, Gordon John
LORIMER, Norman Derek, B.SC.
LOWE, Gordon Richard
LOWE, Gordon William
LUM, Yun Kwai, B.E.
MANNERS, Christopher Charles, B.A.
NOSWORTHY, John Francis Kerrison, B.A.
NUTTER, Peter, B.SC.
PEPPERLE, Stephen David, DIP.TECH.(ENG.)
RANSON, Alfred Joseph William, B.SC.(ENG.)
RATCLIFFE, Gordon Robert
ROBERTS, Thomas
ROSSELLO, Melchor Jose
SHAIKH, Mohammad Saleem Abdul Ganee, B.SC.
SHARP, James Dennis
SINCLAIR, John Alexander
SINGH, Girija Shankar, B.SC.
STREETER, Roy Kirby
TEMPLE, Robert, B.SC.
THOMPSON, Roy William
TINDALE, Roland Wordsworth
WEDDERSPOON, Hamish Bayne, B.SC.
WHITE, Edgar Ian, B.SC.(ENG.)
WILDE, Alwyn Clarence

Students

ABLETT, Roger John Herbert
AMARAWARDENA, Tejakitti Bandula Dias
ANANTHARAJAH, Abraham
ASLAM, Moudood Armad
BARVE, Shashikant Vinayak, B.E.
BATTLEBURY, David Robert
BEACHAM, Kenneth William
BEARDSHALL, Geoffrey Herbert
BOSELEY, Graham William
BOWDELL, Kenneth
CHAN, Yik
CHATER, Brian
CHEH, Huk Wai
CHIU, Pang Kui
DAMANY, Niranjan Laxmichand, B.E.
DAVISON, Frank
DYER, Peter John
EMERY, James Kenneth
FEE, Peter
FLEET, Alan
GOMEZ, Michael Joseph John
HINTON, Roger Nicholas
HUI, Peter Wai Kwan
HUSAIN, Manwar, B.SC.(ENG.)
IP, Hung Kwai
JONES, Brian
KAN, Po Chung
KARIM, Muhammad Rezaul
KARUNARATNA, Edward Walter
KING, Noel Robert Bruce
KO, Chan Man
LAI, Kai Lun
LAM, Chan-Kee
LEE, Kai Ming
LEE, King K.
LEE, Kon Kin
LITTLE, Geoffrey David
LO, Chi Wei
LO, Tzer Hwa
MACHER, Michael Charles
MANZOOR, Tariq, B.SC.(ENG.)
MARCHANT, Michael John
MAY, Kevin Ronald
MITCHELL, Roger George
MOUSLEY, Jeremy Herbert St. Hill
MUHAMMAD, Sardar, B.E.
NG, Fong Fei
NG, Kin Sun
NG, Sik Wai
PALMER, Kenneth Francis
PATEL, Pushpakant Ranchhodbhai
POON, Keng Por
POTTER, Robert James
RATHMELL, Richard Anthony
ROBINSON, Alan John
ROWLAND, Roger Frederick
RYMAN, Geoffrey Ernest
SAYERS, Martin Alan, B.SC.
SCHMIDT, Petrus Phillippus
SIRCAR, Subroto, B.SC.
SMITH, Robin
SOAR, Anthony James
SOBOLEWSKI, John
SPENCE, James George
STARKE, John Eric
THOMAS, David Hartley
THOMAS, Frank Victor
THOMAS, Trevor
THOMPSON, Peter Albert
WALLACE, Peter Richard
WANG, Tak-Kee
WANG, Yee Ming
WARDLE, Ian Edward
WARDLE, Jack
WHITBOURN, Edward Albert
WINTER, Ivan Ronald
WONG, Nai Ping
WONG, Shung Tak
WOOD, Anthony John
WOOLLARD, Alfred James

TRANSFERS: 1st LIST

Student to Graduate

ASPIN, William Melvin, B.SC.
AUSTIN, Malcolm Hugh, B.SC.
BARRACLOUGH, Michael, B.SC.
BELL, Geoffrey, B.SC.
BLYTH, Norman Stewart, B.SC.
BOARDMAN, Keith Derek, B.SC.TECH.
CHANDLER, Kenneth, A.H.-W.C.
CHRISMAS, James Frank
CLARIDGE, John Michael, B.SC.(ENG.)
DALTON, Barry
DAVIS, Brian, B.SC.
DULLEY, Terence Alexander Charles, B.A.
ENSOR, Derek, B.SC.TECH.
FARRANT, Edgar Brian, B.E.
FONES, Derek Roland, B.SC.
FORDER, Roy Arthur, B.SC.(ENG.)
GAMBLE, Keith, B.SC.
GARDNER, David, B.SC.
GOODING, Richard Keith, B.SC.TECH.
HAIR, Hugh Archer, B.SC.
HARRIS, Michael Lile, B.SC.
HAWKINS, John Frederick
HAYTHORNTHWAITE, Sub-Lt. Alfred Ian Carlstrom, B.A., R.N.
HENDERSON, David Michael Stewart, B.SC.
HINTON, James Humphrey, B.A.
HUGHES, Michael Thomas George, B.SC.
JACKSON, Peter Alan, B.SC.
JENKINS, David, B.E.
JOHNSTON, James Neill, B.SC.
JONES, John Elfed
KALSI, Balbir Singh, D.F.H.
KENNEDY, John, B.SC.
KENNEDY, Malcolm William, B.SC.
KHANNA, Rajindar Nath, B.A., B.SC.
KIMBER, William Arthur, B.SC.
LANG, Michael Anthony Ian, B.A.
LEAMAN, Kenneth Arthur, B.SC.(ENG.)
LEWIS, Rhys, B.SC.TECH.
LOH, Peng-Yuen, A.H.-W.C.
MCCLOY, Kenneth, B.SC.
MCSHANE, Robert Rowland, M.SC.
MAWDSLEY, Fred, B.ENG.
MOFFATT, Arthur Murray
MYNOTT, Peter Hall, B.SC.
PALMER, Martin Olaf
RAMSAY, Richard, B.SC.
RAO, Kular Ulya Tilak, B.SC.(ENG.), M.A.SC.
REX, Michael Graham, B.SC.
RICHEY, Gerald McCauley, B.SC.
RODWELL, Raymond George, B.SC.(ENG.)
SARSON, William Charles Turner, B.SC.
SAVAGE, Brian Matthew, B.SC.
STRACHAN, Euan Simpson, B.SC.
SYMONDS, Frederick Walter, B.SC., M.S.
THOMAS, Sub-Lt. Terence Haydn, B.A., R.N.
THORNEYCROFT, Malcolm, B.SC.
TURNER, Kenneth John, B.SC.(ENG.)
WHITEHEAD, Donald Gill, B.SC.TECH.
WILLIAMS, William Peter, B.SC.

ELECTIONS: 2nd LIST

Graduates

ASHTON, Joseph Eric
BAXTER, Burry Lionel Harry, B.SC.
BRYAN, Michael Eric, B.ENG.
BYERS, Fl.-Officer David John, B.SC., R.N.Z.A.F.
EATON, Lt. Kenneth John, B.A., R.N.
ENGLISH, Christopher Durrant, B.SC.
GORSKI-POPIEL, Jerzy, B.SC.(ENG.)
HARDING, John Howard, B.SC.
HARWOOD, William Richard
RICHARDSON, Lyall, B.SC.
ROCK, Alan
SCALES, David Gerald
WARD-LEE, Patrick John
WILLETTS, Frank George, B.SC.
WILSON, William, B.SC.
YOUNG, Kwok-Ping, B.E.E., M.E.E.

Students

ARNOLD, Raymond James
CHEN, Paul Pao-Sun
CHOUDHURY, Mahmud Hossain
COOPER, Lawrence Curteis
DAYARATNA, Petikirige
DIXON, David Michael
DRAVID, Vijay Nilkanth, B.E.
FAKHRI, Zainuddin Abdul
HOUGH, James Kenneth
IBBOTT, John David
ING, John
MACLAUCHLAN, John Beaumont
MEHTA, Praful Mansukhlal, B.E.
MEREDITH, Michael John
MOUSSAVI, Ahmad
PAGE, Donald Stephen
PAREKH, Pravin Chandra
PARKMAN, Phillip Robert
QUEK, Peck Cheng
RASHID, Mohsinali Gulamali
SABER, Mohammed Abdur Rakib
SMITH, Dale
STEEDMAN, Robert William
STEPHENSON, Michael Richard
THAI, Tuck Swee
TUCK, Michael John
WILKINSON, Ronald
WINSLOW, Terence Raymond
YASIN, Inayat Ahmad, B.SC.(ENG.)

TRANSFERS: 2nd LIST

Student to Graduate

ALARIBE, Augustine S. Ahuchogu
BECKETT, James Gilbert, B.SC.TECH.
BLOOM, Ralph Victor, B.SC.
BROWN, Peter, B.SC.TECH.
CHILVERS, Peter William Charles, B.SC.
DOUGLAS, James Stuart, B.SC.
DUNMORE, Edward John, B.SC.(ENG.)
DYSON, Paul Joseph, B.SC.TECH.
FIELD, Richard, B.A.
HARKNESS, Eric Harold, B.SC.(ENG.)
HEARN, Anthony George, B.SC.TECH.
HILES, Christopher, B.SC.(ENG.)
HITCHEN, Grahame Barrington, B.SC.TECH.
LEE, John Leslie, B.SC.TECH.
LEUNG, Wai Sun
MOSS, Peter Barrie, B.SC.TECH.
MURTHY, Surapaneni Radha Krishna, B.SC.
PARR, Peter James, B.SC.
RAE, Robin James, B.SC.TECH.
ROBB, Norman Garside, A.H.-W.C.
RUFFLE, Alan Keith, B.SC.
SMITH, Colin James, B.SC.

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 9TH SEPTEMBER 1960

	no. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	922	9634	9	7
£2 to <£5	2280	6295	14	3
under £2	29068	15285	18	5
		47082	5	3

SPECIAL ADVISORY COMMITTEE OF THE COUNCIL

THE Special Advisory Committee, who, as announced in the November 1959 *Journal*, p. 649, were appointed by the Council of The Institution to consider comments and suggestions made by members at the three Special General Meetings held in 1959 and in correspondence connected therewith, have now presented their report. The Council have directed that copies of it should be circulated to all Corporate members and Associates, and this is being done. Other members may obtain a copy by application to the Secretary of The Institution.

ASWAN HYDROELECTRIC SCHEME

A JOINT Meeting of The Institution of Civil Engineers and The Institution of Electrical Engineers will be held at The Institution of Civil Engineers, Great George Street, Westminster, London S.W.1, on Tuesday, 22nd November 1960, when Mr. Valter Furuskog, C.E., M.A.S.C.E., and Mr. G. F. Kennedy, M.A., M.I.C.E., M.I.MECH.E., M.I.E.E., will present their paper entitled 'The Aswan hydro-electric scheme'. The meeting will start at 5.30 p.m., and tea will be served from 5 p.m.

It is hoped that copies of the paper will be available by the end of October; they will be obtainable on application to the Secretary of The Institution.

THE LATE HENRY JOSEPH NUNN

THE Council of The Institution, at their last meeting, learned with deep regret of the death at the age of 71 of Mr. H. J. Nunn, who served for 48 years as a full-time member of the Institution staff until 1950 and thereafter for nine years, until September 1959 when he finally retired, in a part-time capacity on Benevolent Fund duties.

During the course of this long service on the staff, he was concerned in the main with membership matters, secretarial duties for the Wireless Section, as it was then known, and the Benevolent Fund, for the Court of Governors of which he also acted as Warden of the Chesters Residential Estate, New Malden, Surrey, from 1950 to 1959.

During the Second World War, he was in charge of matters connected with National Service and served on the Electrical Engineering Advisory Committee of the Ministry of Labour and National Service.

The nature of his work necessarily brought him into close contact with many members of The Institution, who will have kindly recollections of his ready helpfulness and will wish to join the Council in their expression of sympathy with his widow.

PUMPED-STORAGE SCHEMES

A NOMINATED Lecture entitled 'Blaenau Ffestiniog and other medium-head pumped-storage schemes in Great Britain' will be delivered by Mr. H. Headland, M.SC., M.I.MECH.E., at The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S.W.1, on Wednesday, 23rd November 1960 at 6 p.m. Members of The Institution of Electrical Engineers are invited to attend.

RELIABILITY AND QUALITY CONTROL

A SYMPOSIUM on reliability and quality control is to be held at the Bellevue-Stratford Hotel, Philadelphia, Pa., U.S.A., from the 9th to 11th January 1961. The symposium is being organized jointly by the American Society for Quality Control, the Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Electronic Industries Association.

Sessions of the symposium will deal with statistical techniques, reliability and quality control education, reliability management, models and mathematics, accelerated testing, system reliability, cost considerations, design techniques, reliability prediction, reliability and quality control programmes, and reliability testing. Two training sessions and a round-table discussion will complete the symposium.

Registration forms and further information may be obtained from the Area Chairman for the United Kingdom, Mr. R. Brewer, Research Laboratories of the General Electric Co. Ltd., Wembley, Middlesex.

MICROWAVE THEORY AND TECHNIQUES

A SYMPOSIUM organized by the Professional Group on Microwave Theory and Techniques of the Institute of Radio Engineers, which will take place from the 15th to 17th May 1961 at the Sheraton Park Hotel, Washington, D.C., U.S.A., will deal with all fields of microwave research, development, and application. Particular attention will be paid to precision microwave measurements, solid-state microwave devices, and sources and components at millimetre waves.

Further information is available from the Chairman of the Technical Programme Committee, Mr. G. Shapiro, Engineering Electronics Section, National Bureau of Standards, Washington 25, D.C.

Announcements to members (continued)

ARRANGEMENTS WITH ENGINEERING INSTITUTIONS OVERSEA

MEMBERS who may have to travel abroad are reminded that, in certain countries, reciprocal arrangements are in operation with engineering institutions for the extension of privileges to visiting members. The complete list of institutions concerned is as follows:

country	*institution*
Australia	Institution of Engineers, Australia
Austria	Österreichischer Ingenieur- und Architekten-Verein
Belgium	Société Royale Belge des Ingénieurs et des Industriels
	Société Belge des Électriciens
Brazil	Instituto de Engenharia
Canada	Engineering Institute of Canada
Ceylon	Institution of Engineers, Ceylon
Denmark	Dansk Ingeniørforening
Finland	Suomen Teknillinen Seura
	Tekniska Föreningen i Finland
France	Société des Ingénieurs Civils de France
	Société Française des Électriciens
Germany	Verein Deutscher Ingenieure
	Verband Deutscher Elektrotechniker
Holland	Koninklijk Instituut van Ingenieurs
Iceland	Association of Chartered Engineers in Iceland
Ireland	The Institution of Civil Engineers of Ireland
India	Institution of Engineers, India
Italy	Associazione Elettrotecnica Italiana
	Associazione Nazionale Ingegneri e Architetti Italiana
Japan	Institute of Electrical Engineers of Japan
New Zealand	New Zealand Institution of Engineers
Norway	Norsk Elektroteknisk Forening
	Den Norske Ingeniørforening
Pakistan	Institution of Engineers, Pakistan
Portugal	Ordem dos Engenheiros
Rhodesia	Rhodesian Institution of Engineers
South Africa	South African Institution of Civil Engineers
	South African Institute of Electrical Engineers
	South African Institution of Mechanical Engineers
Spain	Instituto de Ingenieros Civiles de España
Sweden	Svenska Teknologföreningen
Switzerland	Schweizerischer Ingenieur- und Architekten-Verein
Turkey	Turkish Engineering Society
United States	American Institute of Electrical Engineers
	American Institute of Chemical Engineers
	American Institute of Mining and Metallurgical Engineers
	American Society of Civil Engineers
	American Society of Mechanical Engineers
	Institute of Radio Engineers

The Secretary of The Institution of Electrical Engineers will gladly provide letters of introduction for members visiting these countries.

THE INSTITUTION TIE

SUPPLIES of the Institution tie and of a square (30 × 30in.) of the same design can be obtained on application to the Secretary of The Institution. The charges, which are as follows, are intentionally kept low, but any profit is allowed to accumulate and is then transferred to the Incorporated Benevolent Fund.

Ties:	
silk (heavy quality)	£1 3s. 6d.
Terylene	18s. 0d.
Square:	
Terylene	£2 2s. 0d.

The general appearance of the tie may be seen from the accompanying illustration.

A wavy gold line edged in red, running diagonally across the navy-blue background of the tie, represents wave motion, one of the fundamental concepts of electrical engineering which appear on The Institution's coat of arms.

A shield of light blue—by common consent the predominantly 'electrical' colour—shows a winged golden thunderbolt enclosed in a golden ring bearing golden fleurs-de-lis at the four cardinal points. This alludes to the power of electricity circumscribed and under control; the fleurs-de-lis on the encircling ring make a passing reference to the compass card and thus to our seal and to the work of Kelvin.

SOLID-STATE CIRCUITS

A CONFERENCE on solid-state circuits will be held from the 15th to 17th February 1961 at the University of Pennsylvania and the Sheraton Hotel, Philadelphia, Pa., U.S.A.

The conference, which is sponsored jointly by the Institute of Radio Engineers, the American Institute of Electrical Engineers and the University of Pennsylvania, will deal with circuit properties, circuit philosophy and design techniques relating to solid-state devices.

Further information may be obtained from the Programme Chairman, Mr. J. J. Suran, Building 3, Room 115, General Electric Company, Electronics Park, Syracuse, N.Y., U.S.A.

ARTICLES IN THE TECHNICAL PRESS

TO enable the technical Press to publish as soon as possible new material of topical interest dealt with in papers accepted for reading before The Institution, an author of such a paper

is at liberty to offer a more popular, less technical and shorter article for publication in the technical Press before the reading of his formal Institution paper on the same subject, provided that the article does not appear before the paper has been published individually and that the article makes reference to the paper.

Similarly, the author of a paper which has been accepted for publication only may proceed forthwith to prepare an article for the technical Press, but it must not appear before the paper has been published in the *Proceedings* or as a Monograph, and it must be accompanied by a suitable acknowledgment.

STUDENTS' QUARTERLY JOURNAL

IN its 60 pages, the September 1960 issue of the *Students' Quarterly Journal* contains an 8-page article on aircraft radio services by P. J. G. Hetzel, and a shorter article dealing with fully automatic aircraft landing approach by J. M. Walker. Other articles discuss aluminium in electrical engineering (P. J. H. Rata), light-sensitive cells (K. I. Bartlett), oscillographic displays (J. J. Matthews), and hydroelectric power in Norway (T. R. Forfod).

There is an account of the North-Western week-end meeting 1960, as well as the customary Graduate and Student Section reports. D. A. J. Curry writes about the Young Trophy 1960, and the issue also has a number of book reviews and an item of correspondence.

GLOBAL COMMUNICATIONS

A SYMPOSIUM on global communications, to be known as GLOBECOM V, will be held from the 22nd to 24th May 1961 at the Hotel Sherman, Chicago, Illinois, U.S.A. It will be sponsored by the American Institute of Electrical Engineers, and the Professional Group on Communications Systems of the Institute of Radio Engineers.

Areas of interest include transmission systems, techniques and problems, and systems aspects, and further information can be obtained from Mr. D. C. Campbell, Technical Programme Committee, I.T.T.-Kellogg, 5959 S. Harlem Avenue, Chicago 38, Illinois, U.S.A.

RADIO HOBBIES EXHIBITION

THE International Radio Hobbies Exhibition, organized by the Radio Society of Great Britain, will be held at the Royal Horticultural Society's Old Hall, Westminster, London S.W.1, from the 23rd to 26th November 1960. The show will be open from 11 a.m. to 9 p.m. daily (admission 2s.).

Forthcoming events at Savoy Place

ALL meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

ED EDUCATION DISCUSSION CIRCLE
E ELECTRONICS AND COMMUNICATIONS SECTION
M MEASUREMENT AND CONTROL SECTION
MED MEDICAL ELECTRONICS DISCUSSION GROUP
O ORDINARY
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has now been published is added the month when a synopsis appeared in the *Journal* under 'Papers and monographs published individually this month', i.e. about the time when the paper was published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read. The full list of London meetings is given in the meetings card

October 1960

S **19** *Wednesday* J. E. L. ROBINSON, M.SC. Chairman's Address 'The developing engineer'‡

M **25** *Tuesday* E. H. COOKE-YARBOROUGH, M.A., *and* R. C. M. BARNES, B.SC.(ENG.) 'Rapid methods for ascertaining whether the activity of a weak radioactive sample exceeds a predetermined level' (paper 3258M) *synopsis:* July 1960

E **26** *Wednesday* T. B. D. TERRONI, B.SC. Chairman's Address 'Channelling—a sketch'‡

O **27** *Thursday* A. HEWISH, M.A., PH.D. Lecture on 'The principles and operation of large radio telescopes'‡

November 1960

M **1** *Tuesday* G. G. HAIGH. Lecture on 'Transistor instrumentation in rockets'†

E **2** *Wednesday* PROF. W. J. G. BEYNON, PH.D., D.SC. Lecture on 'The ionosphere—a review of recent progress'†

3 *Thursday* W. ABBOTT, C.M.G., O.B.E., PH.D., B.SC. 'The training of oversea graduate engineers, with particular reference to the F.B.I. scholarships scheme' (paper 3358) *synopsis:* see p. 603 (Joint Meeting with The Institutions of Civil and Mechanical Engineers)

MED **4** *Friday* A. SPENCER-PATTERSON, M.D., M.R.C.P., *and* W. H. STANTON will open a discussion on 'Electro-convulsive therapy'* (at 6 p.m., tea at 5.30 p.m.)

I **7** *Monday* LORD JAMES OF RUSHOLME will open a discussion on 'The impact of television on society'*

M **8** *Tuesday* Section Dinner (at the Café Royal, at 7 for 7.30 p.m.)

U **10** *Thursday* PROF. F. C. WILLIAMS, O.B.E., D.SC., D.PHIL., F.R.S., E. R. LAITHWAITE, M.SC., PH.D., J. F. EASTHAM, M.SC., *and* L. S. PIGGOTT, M.SC.(ENG.) 'The logmotor—a cylindrical brushless variable-speed induction motor' (paper 3149U) *synopsis:* February 1960; PROF. F. C. WILLIAMS, O.B.E., D.SC., D.PHIL., F.R.S., E. R. LAITHWAITE, M.SC., PH.D., J. F. EASTHAM, M.SC., *and* W. FARRER, B.SC. 'Brushless variable-speed induction motors using phase-shift control' (paper 3262U) *synopsis:* May 1960

11 *Friday* THE RT. HON. THE VISCOUNT CALDECOTE, D.S.C., M.A. Lecture on 'The future of "electrics" and "electronics" in aircraft and guided missiles'† (Joint Meeting with the Royal Aeronautical Society)

E **14** *Monday* G. B. B. CHAPLIN, M.SC., PH.D., *and* R. W. A. SCARR, B.SC.(ENG.), PH.D., will open a discussion on 'Tunnel-diode applications and circuitry'†

M **15** *Tuesday* T. GLUCHAROFF, M.E. 'Discrete analogue-computer compensation of sampled-data control systems' (paper 3341M) *synopsis:* see p. 603 (to be read by J. H. WESTCOTT, B.SC.(ENG.), PH.D.)

S **16** *Wednesday* E. H. COX *and* R. E. MARTIN 'Radiocommunication in the power industry' (paper 3290S) *synopsis:* July 1960

22 *Tuesday* V. FURUSKOG *and* G. F. KENNEDY, M.A. 'The Aswan hydro-electric scheme' (Joint Meeting with The Institution of Civil Engineers at The Institution of Civil Engineers, Great George Street, London S.W.1)

E **22–24** *Tuesday–Thursday* Conference on electronic telephone exchanges (all wishing to attend are required to register; forms on application to the Secretary of The Institution)

ED **28** *Monday* PROF. G. H. RAWCLIFFE, M.A., D.SC., *and* G. A. V. SOWTER, PH.D., B.SC.(ENG.), will open a discussion on 'Training for research'* (at 6 p.m., tea at 5.30 p.m.)

E **30** *Wednesday* W. J. BRAY, M.SC.(ENG.). Lecture on 'The potentialities of artificial earth satellites for radiocommunication'†

* No advance information will be available and no Press report will be permitted
† An abstract will be available in advance
‡ No advance information will be available

Contents of the current *Proceedings*

The date in italics is that of the Journal review, special article, or synopsis. Where given, the date in capitals is the month in which a paper or monograph was published individually

PART A. POWER ENGINEERING (OCTOBER 1960)

G. F. SHOTTER. PAPER 3343 **Electricity meters** (Review of progress) *November 1960*

Communicated discussion on **Electrostatic dust monitor**

B. SALVAGE, B.SC.(ENG.), PH.D., *and* J. A. M. GIBBONS, B.SC. PAPER 3143S, DECEMBER 1959 **Impulse strength of fully-impregnated-paper dielectrics as used in high-voltage cables** *May 1960*

E. L. WHITE, B.SC.(ENG.). PAPER 3286S **Experimental study of surges and oscillations in windings of core-type transformers** *October 1960*

B. L. COLEMAN, B.SC. PAPER 3287S **Oscillations in a transformer winding** *October 1960*

G. W. BOWDLER, M.SC., *and* R. C. HUGHES, B.SC. PAPER 3317S **Surge flashover voltages of air-gaps associated with insulators and bushings** *October 1960*

Discussion on **Design of housing-estate distribution systems using a digital computer** before the Sheffield Sub-Centre

J. P. MCBREEN. PAPER 3215U, FEBRUARY 1960 **Some considerations in the application of power rectifiers and convertors** *May 1960*

Communicated discussion on **Discrimination between h.r.c. fuses**

B. E. A. VIGERS, M.A., *and* R. O. FLETCHER, B.SC. PAPER 3196U, FEBRUARY 1960 **Electricity in the manufacture of hydrogen peroxide** *May 1960*

E. R. LAITHWAITE, M.SC., PH.D., *and* G. F. NIX, M.SC. PAPER 3273U **Further developments of the self-oscillating induction motor** *October 1960*

Communicated discussion on **Submersible pumping plant**

C. J. CARPENTER, M.SC.(ENG.). PAPER 3327U **Application of the method of images to machine end-winding fields** *October 1960*

Discussion on **Electrical supplies to power station auxiliaries** before the North-Eastern Centre and the South Midland Supply and Utilization Group

Discussion on **Design of electro-mechanical auxiliaries directly associated with power-producing reactors** before the Western Supply Group

PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (SEPTEMBER 1960)

See the Journal for September 1960, p. 561

PART C. MONOGRAPHS (SEPTEMBER 1960)

See the Journal for September 1960, p. 561

BULLETIN OF THE SECTIONS

SUPPLY

IN RETROSPECT

TEMPUS fugit, sic transit gloria, etc.—they all apply when a Chairman nears the end of his brief term of office. A long apprenticeship, two or three years as a Committee member, then three years as a Vice-Chairman and finally a year as Chairman.

What are his impressions? First, the Address has to be prepared. He reckons he has about six months in which to do it: this is suddenly reduced to four to allow for editing and printing. Business requires his absence abroad for six weeks, and he is left with a bare ten to prepare it and catch up with arrears of work. Should he confine himself to his special field or accept the freedom granted him by there being no discussion? Somehow it is done. The great day arrives and is over.

Timing problems

The paper presented at the first meeting is not over-contentious and there is an adequate discussion. However, the next meeting is on a cable topic, and the list of members wanting to take part in the discussion is formidable. Allowing for a few additional speakers, and bearing in mind that it is a discussion and not a debate, the Chairman allows each member approximately eight minutes. With reluctance, he has to curtail a few, but he retires gracefully before the member who starts to produce slides at the ninth minute. Fortunately, all members are not discursive, and, to his relief, the time schedule is not too badly out.

There is also the social side. The Dinner-Dance is much oversubscribed, and a member who annually brings a party is on the waiting list. The Section Secretary and Chairman visit the site and with the local construction engineer examine possibilities. An experiment in accommodating the numbers is agreed. The evening arrives—will it be a success or not? The duties of the Chairman are light, the main one being to avoid holding up the proceedings with lengthy speeches. The evening is a success, though it is difficult to tell the Chairman so, as the band are confusing quantity with quality.

The visit to Cambridge, including a tour of the colleges—will it rain? Dull, but no rain and again enjoyed by all. This was followed by the visit to Cardiff at the end of September.

By now the Chairman has realized that all functions are made or marred by the people attending them and the contribution of the Chairman to their success is small. He knows his Section and is assured of their active co-operation, whether a paper is being read or a social function being attended.

J. R. MORTLOCK

Footnote

Dr. Mortlock's modest account of his year of office makes no reference to the extent of his professional activities. That the past year has been hectic for him is no understatement. Apart from his duties as Chairman, he has visited on separate occasions Australia, Canada, France and the Soviet Union. Nor has his private life been uneventful, for between excursions he has 'given away' two daughters. Thus, fully and with completeness can he say 'tempus fugit, sic transit gloria'.

F. C. W.

CROSSING-POINT

THE beginning of October saw the crossing over of Chairman, Vice-Chairmen and some Committee members.

Mr. J. E. L. Robinson, the incoming Chairman, made his appearance at Savoy Place at a tender age, when in conjunction with Dr. J. L. Miller he presented papers on high-speed cathode-ray oscillography. At that period his training and interests were in the transformer world, but, with the advent of war, artillery, signals and radar filled his Service life.

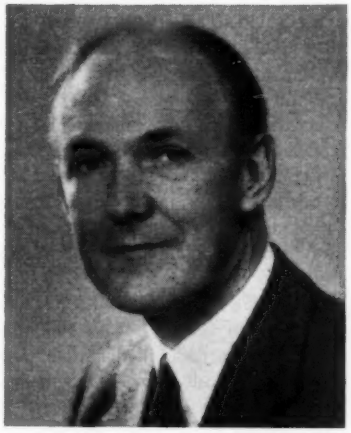
He became manager of the transformer department of Ferranti in 1946 and shortly afterwards recommenced activities in The Institution. Serving on the Council from 1949, part of his term was spent simultaneously on the Committee of the Supply Group of the North-Western Centre, of which he held the Chair in the 1953–54 Session. This period also saw Mr. Robinson serving on the Supply Section Committee. In 1954 he was elected a member of the Committee of the North-Western Centre and served as a Vice-Chairman from 1956 to 1958. During this time he returned to the Supply Section Committee, becoming a Vice-Chairman in 1957. In 1958 he altered his vocation to associated interests away from the north-west.

This brief record shows that our genial Irish-born Chairman has already served The Institution well and faithfully, and there can be no doubt that the present session will see him fulfilling the highest traditions of his office.

Of the two Vice-Chairmen, Dr. J. S. Forrest continues in that office, while Mr. C. H. Flurscheim enters his term from being an ordinary member of the Committee. Both are well known in their spheres of activity, namely research on supply problems and supply-equipment manufacturing respectively. They will continue to bring strength to the Committee.

The ordinary members, Mr. E. S. Booth, Prof. M. W. Humphrey Davies, Mr. N. G. Simpson and Mr. F. C. Walmsley, combine three newcomers and one returning member. Mr. Booth is well versed and well known for his work on generation. Prof. Humphrey Davies represents the academic field and has pronounced interests in the problems associated with power-system behaviour. Mr. N. G. Simpson covers the important aspect of overhead-line work, in which he is a recognized expert. Mr. F. C. Walmsley comes from the manufacturing side and has previously served on the Committee.

F. C. W.



Mr. J. E. L. Robinson

WIDE REPRESENTATION

UTILIZATION

AT the start of the 1960–61 Session, the new members of the Utilization Section Committee take office. In common with all Institution committees, every effort is made to appoint members who can be adequately representative of the very wide scope of the Section. Increasingly, electricity is playing a key part in the life of industry as a source of power and a nervous system, and domestically to provide better conditions, and all these applications are included within the scope of the Section.

Very careful consideration was given, therefore, by last year's Committee to selecting and nominating new members who could maintain this wide over-all representation. As all the members nominated were elected, it must be presumed that members of the Section endorse the opinions of the Committee.

Heavy electrical manufacturing is represented by Mr. J. E. Boul, manager of the rectifier substation department of the English Electric Co. Mr. A. V. Lawry, joint managing director of Contactor Switchgear, is well qualified to guide the Committee in the important field of control gear. One of our most significant basic industries, steel, will be represented by Mr. P. M. Martin, chief engineer of the Midland Division of Richard Thomas and Baldwins. Standards in electrical supply and installation are of vital interest to the Section, and here Mr. A. V. Milton, director of A. V. Milton, will be able further to reinforce the representatives already on the Committee.

Finally, help from the universities is always welcomed, and Prof. G. H. Rawcliffe, Professor of Electrical Engineering at Bristol, has shown from his own research work a particular interest in industrial machines. As might be expected, all these new members have a background of very active Institution work, many having served as Chairmen of their own Centres, and their presence on the Committee will strengthen the ties of the Utilization Section with the Centres outside London.

The London programme

In the London programme, two evenings, the 10th November 1960 and the 12th January 1961, are chosen for reading and discussing papers dealing with new and ingenious

ways of designing squirrel-cage induction motors, to give, first, variable speed and, secondly, two alternative speeds. On the 8th December 1960, a paper on 'The determination of the electrical characteristics of an arc furnace' is being presented. Great interest now centres on the economies and other possible advantages of this type of furnace compared with more conventional furnaces for the production of carbon steels, and this meeting should lead to a good discussion.

If any member feels that the choice of papers indicates a specialist bias, the remedy may lie with himself. The Committee are particularly anxious to stimulate papers of wide general interest, and the utilization field is one rich in material for such papers. J. M. F.

ELECTRONICS AND COMMUNICATIONS

THE NEW CHAIRMAN

MR. T. B. D. TERRONI joined The Institution as a Student in 1923, and was elected an Associate Member in 1933 and a Member in 1944. He is a Past-Chairman of the Mersey and North Wales Centre, and a Faraday Lecturer.

He was born in London in 1904 and was educated at Archbishop Tenison's Grammar School and at the City and Guilds Engineering College, where he took an honours degree in engineering followed by a postgraduate course. In addition to his degree he was awarded an Associateship of the City and Guilds of London Institute and a Diploma of Imperial College.

After early training with Ferranti Ltd., he joined the International Telephone and Telegraph Laboratories in 1927, where he was concerned with research and development in the telecommunication field, with special reference to interference problems. In 1931 he joined the Automatic Telephone and Electric Co. to take up line-transmission developments in the carrier field, initially for power-line applications, followed by specialization in telephone-line communication.

During the Second World War, he was responsible for the design of quartz crystals and the setting up of a pilot manufacturing plant for crystals for the Services; this work was carried out in addition to his other activities, which had spread into the radiocommunication field. He is at present manager and chief engineer of the transmission division of the Automatic Telephone and Electric Co.

Mr. T. B. D. Terroni

MEASUREMENT AND CONTROL

TAKING STOCK

AT the beginning of a new session it is perhaps fitting that we should pause and take stock of what has been accomplished in the year gone by and what we have to look forward to in the year to come. The Section has been fortunate in having Prof. A. Tustin as its Chairman, and those who attended will still have a vivid recollection of his most interesting inaugural address last October on 'The relationship of physical mechanisms to psychological processes'.

Under his able guidance, many successful meetings followed which amply covered the Section's ever-widening scope. They included meetings dealing with specialized subjects, such as electronic multipliers, sequence networks, caesium standards, the M.K.S. system, chopper-type amplifiers, component selection and testing, and thermistors, besides discussion meetings on broader lines, such as on memory stores, data-handling problems in atomic installations, Soviet control-engineering progress, digital-computer developments, and teaching and learning machines.

The Section Dinner was held in November 1959 at the Café Royal, and there was a well attended visit to Standard Telecommunication Laboratories at Harlow last May, both of which events were very successful. The two-day discussion meetings held last January (in association with the British Computer Society) on the engineering and managerial aspects of reliability and maintenance of digital-computer systems were also outstanding. Besides these meetings, the Section sponsored several papers which have now been published in the *Proceedings*.

Programme highlights

Our Chairman for the coming session is Mr. C. G. Garton, who is well known to many for his lucid expositions on the subject of insulation. The programme arranged for the first half of the 1960–61 Session includes a lecture on 'Precision measurement' by G. H. Rayner and A. Felton of the National Physical Laboratory, supported by four papers, and one on 'Transistor instrumentation in rockets' by G. G. Haigh of the Royal Aircraft Establishment, Farnborough. There will be discussion meetings on digital transducers and machine-tool control, and three meetings at which papers will be read.

It will be noted that more than half of the programme comprises lectures or discussions on topics of broad general interest. This practice was started about two years ago, and is designed to encourage larger attendances at meetings than the presentation of only specialized papers could hope to attract. The opportunity of having a selection of the latter read and discussed, however, must not be neglected, as many of them represent important milestones in the progress of The Institution.

J. K. W.

LONDON REPORT

EDUCATION DISCUSSION CIRCLE

RESIDENTIAL SUMMER MEETING

THE best principles of education were followed at the summer meeting this year of the London Education Discussion Circle on the 9th and 10th September 1960. The Circle were guests of the B.B.C. at their Engineering Training Department at Wood Norton, Evesham, a lovely mansion set in ideal surroundings. After the technical work and discussion, a visit to a Shakespeare play gave further stimulus to the event.

B.B.C. training courses

After lunch, the members of the Circle and their ladies were greeted by Dr. K. R. Sturley, who admitted to schizophrenia, since he was a member of the B.B.C., the hosts, and of the Discussion Circle, the guests. Dr. Sturley introduced Mr. E. L. E. Pawley, who welcomed the party on behalf of Sir Harold Bishop. Mr. Pawley outlined the work of the Training Department. Training is given in all aspects of sound and television broadcasting. The various types of course were explained. Mr. Pawley impressed his audience with the planning of the courses and with the great importance given to technicians and their instruction.

Replying on behalf of The Institution, Dr. F. T. Chapman expressed his gratification at the hospitality of the B.B.C. and made, *inter alia*, some amusing suggestions regarding television licences. Prof. M. W. Humphrey Davies also thanked Dr. Sturley and his colleagues for their great kindness.

Laboratory visit

The visit to the actual laboratories was of immense interest. Clearly, a great amount of thought had been devoted to them, and the examples and experiments seen were of considerable potential use to universities and colleges. Several laboratories were looked at in some detail.

In one laboratory there were examples of transistor circuits, synthetic note-sounding apparatus, and practical construction work. In the aerials laboratory, a progressive series of demonstrations explained the fundamentals of radiation, and demonstrated quite clearly the fact that a current *can* flow with only one end of a conductor connected to a terminal. The importance of wave motion was emphasized in another laboratory, which showed the essential unity of various types of wave phenomena, as well as details of acoustic radiation. Of special interest was a small and inexpensive acoustic box for testing the directional properties of, for example, microphones.

Apart from these topics of completely general interest, there were some laboratories devoted to 'special-to-job' tasks. A complete control centre was demonstrated, and its operation explained. A television-lighting studio was seen, and the immense importance of lighting in television soon became apparent in a remarkable fusion of technical and artistic considerations.

Ladies' tour

The ladies present were given their own tour. They were, for instance, intrigued by the mansion itself, built in 1895 by the Duke of Orléans, the Pretender to the French throne. The building is modelled on a French château, with coats of arms, crowns, and fleurs-de-lis everywhere proclaiming the regal connection. There was also the Duke's bath, enormous and of marble and even having entrance steps.

The ladies were shown how colour television could operate, the main features of a television studio, including how to work a television camera, and some of the ideas in lighting and camera work that contribute to their viewing enjoyment.

Recreational

In the evening, the whole party made a trip to Stratford on Avon to see a remarkable performance of 'Troilus and Cressida'. This trip provided mental refreshment, vicarious physical exhaustion, and an opportunity of comparing the lighting techniques of stage and television.

On Saturday morning, most of the party toured, by coach or car, some of the nearby Cotswold villages, and were able to continue discussing the ideas they had acquired during the previous day.

A precedent of a residential summer meeting has been set, and it is to be hoped that future meetings will follow this precedent in many ways.

G. S. B.

News from the Centres

NORTH-WESTERN CENTRE

'Electronics in action'

A TWO-DAY exhibition with the above arresting title was held at the Manchester College of Science and Technology on the 21st and 22nd March 1960. It was sponsored by the North-Western Electronics and Communications Group with the support of the Graduate and Student Section, and was designed to interest young people in the electrical engineering profession. Some hundred grammar schools were notified of it, and of these 25 made organized visits. In addition to advertisements in the local Press, the B.B.C. gave excellent coverage on sound and television. Over 2000 people visited the exhibition, including 600 students in organized parties.

Exhibits were provided and staffed by several firms, by Manchester College of Science and Technology and by Bolton Technical College, as well as by the G.P.O. and the B.B.C. Opposite the entrance was a stand provided by The Institution, at which information was available as to careers in industry.

The working exhibits included such items as a display of the television transmission system by the B.B.C.; methods of locating submarine telephone-cable faults, subscriber trunk dialling, and the South Lancashire radiotelephone scheme by the G.P.O.; electrolytic tanks by Bolton Technical College; working models of hydromatic propellers; an electronic shunting display; an analogue tutor; and a very interesting demonstration board by the British Rayon Research Association. In addition, films such as 'The inquiring mind', 'The conquest of the atom', 'The principles of the transistor', etc. were shown at four film sessions each day.

The impression of those who spent much time at the exhibition is that its object was achieved, and a very lively and intelligent interest was shown by the many visitors. It is the intention to summarize the lessons learnt in the organization of this exhibition, and the earlier one in 1957, to serve as a help in organizing similar exhibitions in the future. Such a report could be made available to any other Centre which might be interested. H. G. B.

The B.B.C. exhibit for 'Electronics in action'

Consumers' Councils in Buganda

THE Uganda Electricity Board attribute the continued growth in the number of new connections in Buganda largely to interest aroused by organized meetings in villages throughout the Kingdom.

Since late 1959, Consumers' Councils have been formed over much of Buganda with a view to spreading information about electricity supplies. At each council, a leader, elected at the meeting, conducts discussions with the prospective consumers on a variety of subjects, including the economics of an electricity supply in the district and the difficulties involved in satisfying applicants. Board officers are present to answer questions arising from the discussions.

Attendance at the councils depends largely on the size of village visited and may vary between 20 and 150. In one very small village it is recorded that 26 applications for supply followed a meeting attended by only 22 people.

Consumers' Councils have been instrumental in increasing the number of applications for supplies in rural parts of the Victoria area to about 400 a month. Development schemes which would not otherwise have been considered are now being prepared for some areas where these meetings have taken place. Through the councils, the Board are now advised as to the demand for electricity in certain localities and can act on firm estimates of likely consumption.

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Deputy Representative: F. R. WARDROP, B.SC.(ENG.), Central Electricity Board, P.O. Box 1003, Kuala Lumpur, Malaya

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